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THESIS

RISK
IN
MILITARY OPERATIONS

by

P. Gardner Howe

December, 1995

Thesis Advisor: Gordon McCormick

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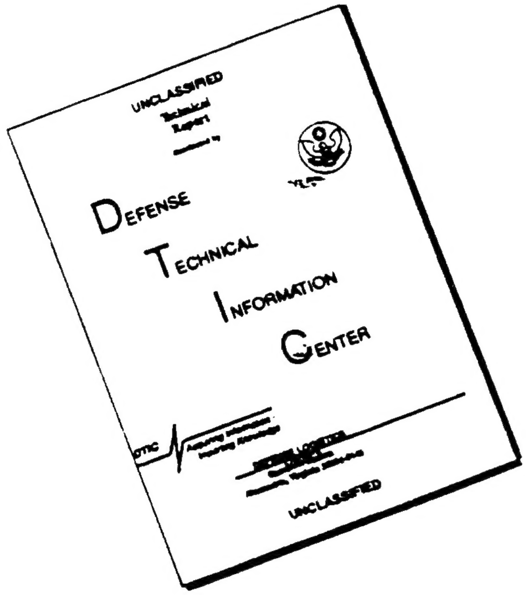

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This thesis describes a military operation's aggregate risk as the sum of two components: the risk of military failure and the risk of political failure. Each component is shown to be usefully represented as a cost-weighted probability and the significant variables affecting the costs of failure and the probability of failure are examined. Based on this conceptual framework, a mathematical model is formulated that illustrates the fluctuations in an operation's political, military and aggregate risk as a function of the amount of control delegated by the political leader to the military commander. Analysis of this model leads to a useful approach for enhancing the success of military operations: command and control arrangements that reflect the optimal delegation of control minimize the operation's aggregate risk and, therefore, increase the likelihood of operational success. The thesis concludes by testing this strategy of risk minimization in two historical case studies and in a hypothetical application to a commando-type special operation.

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RISK IN MILITARY OPERATIONS

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ABSTRACT

This thesis explores the nature and dynamics of risks faced by political leaders and military commanders in the conduct of military operations. It develops a systematic approach to analyzing and an effective strategy for minimizing exposure to risks in military operations.

This thesis describes a military operation's aggregate risk as the sum of two components: the risk of military failure and the risk of political failure. Each component is shown to be usefully represented as a cost-weighted probability and the significant variables affecting the costs of failure and the probability of failure are examined. Based on this conceptual framework, a mathematical model is formulated that illustrates the fluctuations in an operation's political, military and aggregate risk as a function of the amount of control delegated by the political leader to the military commander. Analysis of this model leads to a useful approach for enhancing the success of military operations: command and control arrangements that reflect the optimal delegation of control minimize the operation's aggregate risk and, therefore, increase the likelihood of operational success. The thesis concludes by testing this strategy of risk minimization in two historical case studies and in a hypothetical application to a commando-type special operation.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

This thesis explores the nature and dynamics of risks faced by political leaders and military commanders in the conduct of military operations. It develops a systematic approach to analyzing and an effective strategy for minimizing exposure to risk in military operations.

The political and military risks associated with a military operation often serve as powerful catalysts that trigger a struggle between the political leader and the military commander for control over the operation. Political risks increase the desire for control by the political leader who wants to ensure the tactical objectives and means are consistent with the existing political requirements. Military risks, on the other hand, increase the desire for control by the military commander; he seeks maximum autonomy in order to effectively conduct the battle and respond to contingencies. The end result is the command and control dilemma: each leader is driven by his perception of risks to struggle for increased control over the operation. The model developed in this thesis provides a conceptual framework for analyzing the risks faced by each leader and these risks' relationship with one another.

The thesis shows that an operation's overall risk, or aggregate risk, is the sum of two components: the risk of military failure and the risk of political failure. The elements of these risks, the "cost of failure" and the "probability of failure," are examined in detail and the significant factors that affect each are deduced. A mathematical model is then formulated that provides a mechanism for observing the variations in an operation's military, political and aggregate risk as a function of the delegation of control. Analysis of this risk model yields an effective strategy for managing the command and control dilemma.

In every military operation, a command structure is instituted for the execution of the tactical plan and the control of military units; the establishment of a command relationship between the political leader and military commander implies the delegation of some degree of autonomous decision-making authority. The risk model allows the political leader and military commander to shift their focus from minimizing *component risk* through a *struggle*

for control to minimizing *aggregate risk* through an *optimization* of control. The utilization of command and control arrangements that reflect the optimum level of delegation, as determined by the risk model, results in the minimum possible exposure to overall risk and improves the likelihood of a successful military operation.

Applications to historical cases illustrate the risk model's explanatory power. The first case study demonstrates the usefulness of decentralized control when the political situation permits a high level of delegation to the military commander. In Operation URGENT FURY, the military risks dominated the political risks; the decentralized approach to command and control that was exercised effectively reduced the aggregate risk and granted the military commander the flexibility required to handle the military risks. Operation EL DORADO CANYON, on the other hand, illustrates the necessity for centralized control when the political risks dominate the military risks. This operation's risk of political failure coupled with the relatively low risk of military failure required the political leader retain a high level of control to minimize aggregate risk and provide the flexibility necessitated by the political environment.

The usefulness of the risk model is not limited to explaining risk. An application of the model to a hypothetical special operation demonstrates its role as a predictive tool. Analysis of the aggregate risk solution for a generic commando operation reveals that the optimal command and control arrangement involves procedures that delegate slightly less than half of the control from the political leader to the military commander.

In addition to a strategy of risk minimization, analysis of the risk model also yields a set of general precepts for the management of risk in military operations. Obviously, the minimization of aggregate risk is the most effective means of enhancing mission success. A useful secondary goal, however, is to "lower" the whole aggregate risk curve. Any individual action that lowers either the component military or political risk curve will result

in a lower aggregate risk regardless of the level of delegation. As a result, the following precepts can be derived from the model developed in this thesis:

- Ensure the force is prepared for the operation's tactical environment.
- Ensure the force is prepared for the operation's required military tasks.
- Minimize the number of sequential/simultaneous tasks required by the operation.
- Keep the operation's desired end-state as simple as possible.
- Attempt to minimize variations in the operation's political environment.
- Maximize the coupling between the operation's military objective and its political objective.

The greater the degree to which these precepts are accomplished during the planning, preparation and execution of military operations, the lower the overall aggregate risk exposure and the greater the prospect of mission success.

I. INTRODUCTION

A. PURPOSE

The purpose of this thesis is to explore the dynamics of risk in military operations. In the pages that follow, I hope to shed some light on following questions: What are the underlying sources of the natural tension between political leaders and military commanders in the execution of military operations? What measures can be taken to ensure that the objectives of and tactical means employed in any given operation are consistent with that mission's political and operational requirements? What is the optimum system of control to ensure successful political-military integration in the execution of military operations?

B. THE COMMAND AND CONTROL DILEMMA

As Clausewitz noted, "war is nothing but the continuation of policy with other means" (Howard 1984, 225). The success of any military application of force, then, requires (1) that political objectives are appropriately determined and attained, and (2) that military objectives are appropriately determined and attained. Difficulties in controlling military operations stem from the fact that separate organizations are normally responsible for determining and attaining these objectives. In the United States, for instance, the National Command Authority is responsible for strategic policy while military commanders are responsible for tactical planning and execution. Organization theory suggests that such functional specialization gives rise to an inherent command and control dilemma: each organization will seek maximum autonomy (i.e. control over the military application of force) in order to minimize its uncertainty. Given that such control is zero-sum, an increase in one organization's control dictates a decrease in the others. Additionally, the greater the uncertainty faced, the stronger the desire for autonomous control.

C. RISK AND THE COMMAND AND CONTROL DILEMMA

I believe that the key to understanding the command and control dilemma can be found in the concept of risk in military operations. Analytic insight into the dynamics of risk

in military operations provides not only a useful tool for understanding the nature of the command and control dilemma but also a means for managing its effects.

More so than uncertainty, the political and military risks associated with a military operation serve as powerful catalysts for the struggle over control. The execution of a special operation serves as a useful example. The very nature of special operations suggests that the command and control dilemma will be greatly amplified during the planning and execution of such military evolutions. The high political risks normally associated with special operations increase the desire for control by the political leader; he wants to ensure the tactical objectives and means are consistent with the existing political requirements. The high military risks, on the other hand, increase the desire for control by the military leader; he desires maximum autonomy in order to effectively conduct the operation and respond to contingencies. Thus, each leader is driven by his perception of risks to struggle for increased control over the operation. The model developed in this thesis provides a conceptual framework for analyzing the risks faced each leader and their relationship to each other; such an understanding of the nature and dynamics of risk in military operations is essential to managing the command and control dilemma.

In every military operation, a command structure is instituted for the execution of the plan and the control of the military units; the establishment of a command relationship between the political leader and military commander implies the delegation of some degree of autonomous decision-making authority. In general, the risks faced by the political leader and military commander are inversely related to their respective levels of control. The challenge is to minimize an operation's aggregate risk (political risk and military risk) by optimizing command and control. The risk model developed in this thesis allows one to do just that.

D. THESIS OVERVIEW

In Chapter II, this thesis develops a conceptual framework for analyzing the risk dynamics faced by political and military leaders in the conduct of military operations. In the next two chapters, the causal relationships between the delegation of control and the

fluctuations in an operation's political, military and aggregate risk are identified and analyzed, and a mathematical model formulated. Two case studies are then used in Chapter V to test the explanatory power of the model: Operation URGENT FURY and Operation EL DORADO CANYON. In Chapter VI, the usefulness of the model as a predictive tool is demonstrated with a look at its application to special operations. The thesis concludes with a review of the strengths and weaknesses of the model and recommendations for additional research.

E. A NOTE TO THE READER

This thesis is neither research oriented, nor a scholastic attempt to "prove" a hypothesis. Rather, it is a thesis about ideas, concepts and generalized relationships. Its primary aim is to develop a method for thinking about risk in military operations. The goal is to identify important independent variables, deduce their causal relationships and develop a framework for analyzing risk.

In my review of the literature on command and control and decision theory in warfare, I found a vacuum on the topic of risk. This thesis is my modest attempt to fill this void. I do not pretend to have found "the answer," but rather, offer this thesis as an initial attempt toward increased understanding. If this thesis stimulates additional thinking about the concept of risk in military operations and its relationship with command and control, then I shall think my efforts worthwhile.

II. CONCEPTUALIZING RISK: AN ANALYTIC FRAMEWORK

The purpose of this chapter is to introduce an analytic framework for conceptualizing risk in military operations. In the formulation of any model, a balance must be struck between specificity and generality, between complexity and simplicity. An emphasis on modeling as accurately as possible leads to frameworks in which "the resulting modeled world appears as complex (and thus mystifying) as the concrete world it models." Excessively simple models, on the other hand, are likely to overlook important variables and significant causal relationships; such oversights can lead to a misunderstanding of the modeled phenomenon. A good model, therefore, carefully balances complexity and simplicity, and serves as "an abstract tool of understanding," not an attempt "to reconstruct concrete reality in all its nuances and complexities." (Eckstein 1980, 162)

The framework developed in this chapter provides just such a "balanced" model. It identifies the primary components of risk in military operations, the key factors that influence these components, and the general ways in which all elements of the framework relate to one another. Because the execution of military operations on the modern battlefield is indeed a complicated undertaking and the risks faced by political leaders and military commanders are difficult to assess, the approach taken in this chapter is somewhat abstract and relies on generalizations to simplify the complex nature of combat. It includes, however, a sufficient level of detail to permit a methodical examination of risk in military operations. An assessment of the limitations imposed by the framework's simplifications and their implications on the usefulness on the model will be made in the concluding section.

A. RISK IN MILITARY OPERATIONS

1. Military Operations and Failure

"War is nothing but the continuation of policy with other means." As Clausewitz noted over two centuries ago, the essence of warfare is political; operations in war are simply a military tool to achieve a political end. This view of warfare is central to the framework

presented here. For the purposes of this thesis, a military operation is defined as the tactical application of force employed by a state in the pursuit of specific military objectives that contribute to the attainment of an overall political objective. A graphical representation of this definition is presented in Figure 1. A simplified concept of the "chain of command" is used in this framework and consists of a political leader concerned with the success of the overall military operation, a military commander concerned with the attainment of the military objective, and the military units employed to execute the application of force.

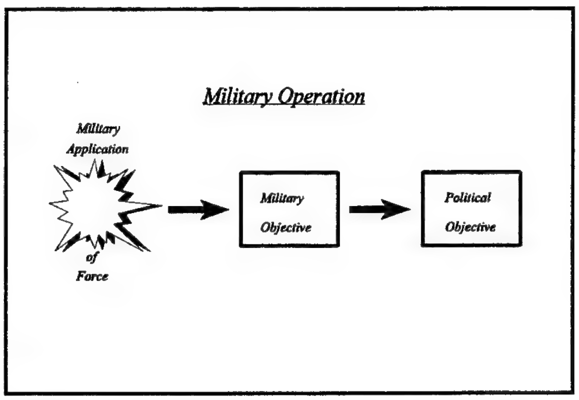

Figure 1. Diagram of Military Operation

The success of any military operation requires (1) that the military objective is appropriately determined and attained, and (2) that the political objective is appropriately determined and attained. Each objective is a necessary but not sufficient condition for success. There are, therefore, two ways in which a military operation can fail: militarily and politically. A military failure occurs when the political objective of a military operation is not attained due the failure of the application of force to achieve the military objective. A political failure occurs when the political objective of a military operation is not attained even though the application of force successfully achieves the military objective. The distinction between these types of failure is graphically represented in Figure 2.

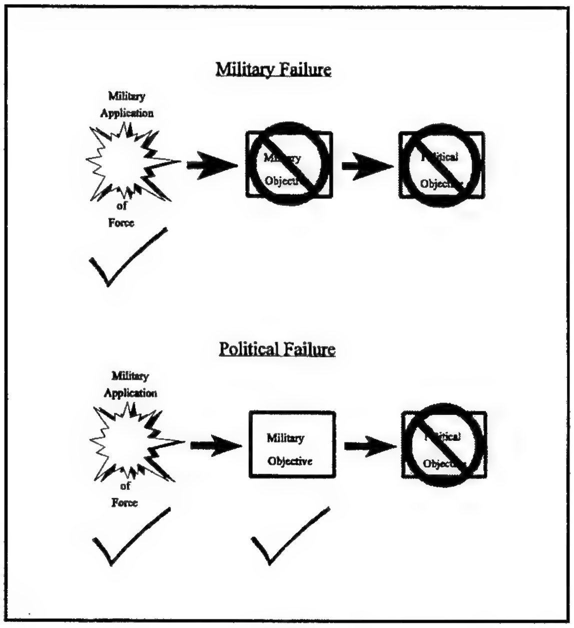

Figure 2. Types of Failure

2. Aggregate Risk in Military Operations

The principal risk associated with a military operation can be conceived of as the risk of failure. Based on the preceding discussion, the aggregate risk of a military operation can be viewed as having two components: the risk of military failure and the risk of political failure. This relationship provides the cornerstone of the analytic framework and is illustrated in Figure 3.

3. Conceptualizing Risk in Military Operations

Risk is normally regarded as the possibility of loss or the chance of incurring some type of liability. In other words, it is usually conceived of in probabilistic terms. In order to analyze and compare separate components of risk, however, it is essential to look at not only the relative probabilities but also the relative costs. The risk of any event, therefore, can be more usefully thought of as the product of (1) the probability of that event occurring, and (2) the cost associated with the event occurring. Conceiving of risk as a weighted probability

allows for more meaningful comparisons between different types of risk. The remaining sections of this chapter apply this concept to the components of risk in military operations.

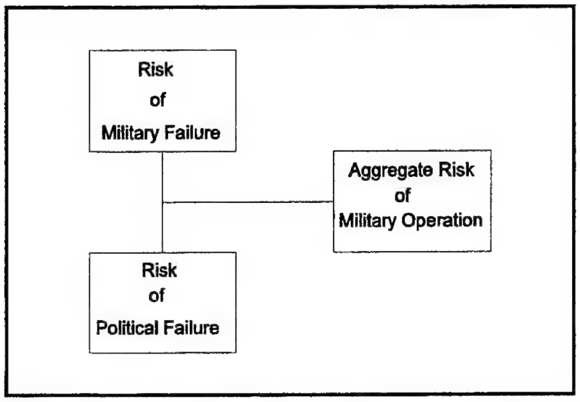

Figure 3. Components of Aggregate Risk

B. THE RISK OF MILITARY FAILURE

1. Components

The risk of military failure is the product of the probability of military failure and the cost of military failure. The probability of military failure is simply the likelihood that a military operation's application of force will fail to achieve the military objective. The costs of military failure are the political consequences incurred by a state as a result of a failure to achieve the military objective. Figure 4 illustrates this relationship.

2. Factors Affecting the Cost of Military Failure

The principal determinants of the cost of military failure are domestic and international politics. The influence of domestic politics is determined by the degree to which a state's domestic audience is sensitive to a military operation and has the means to respond to a military failure. Likewise, the degree to which international politics influence the cost of military failure is determined by the international audiences' sensitivity to a state's military operation and their response capability. These variables have a direct relationship with the cost of a military failure in that an increase in either the sensitivity to a military

operation or the audiences' capability to respond increases the cost. Figure 5 illustrates this relationship.

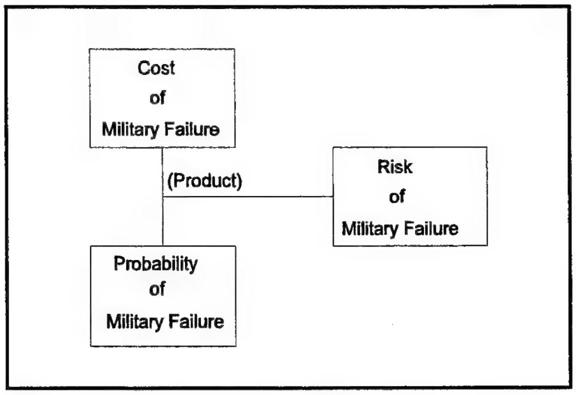

Figure 4. The Risk of Military Failure

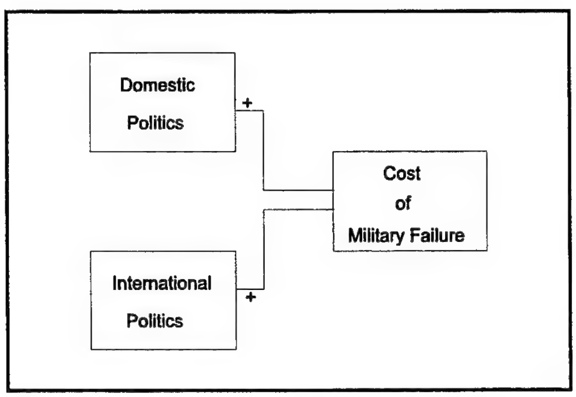

Figure 5. The Cost of Military Failure

3. Factors Affecting the Probability of Military Failure

The principal factors affecting the probability of military failure are (1) the challenge of the tactical environment, (2) the readiness of the force, (3) the complexity of the military operation, and (4) the delegation of control. (See Figure 6).

a. The Challenge of the Tactical Environment

The challenge of the tactical environment refers to the degree to which factors outside the direct control of the military force pose obstacles to the force in its attempt to

attain the military objective. Such factors include geography, the enemy order of battle, environmental conditions and the tactical dynamism (the rate of change of such tactical considerations). The challenge of the tactical environment has a direct relationship with the probability of military failure; all other factors held constant, an increase in the challenge of the tactical environment leads to an increase in the probability of military failure.

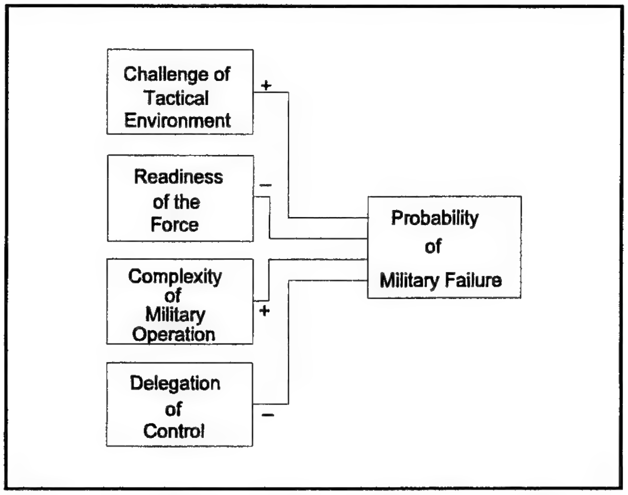

Figure 6. The Probability of Military Failure

b. The Readiness of the Force

The readiness of the force refers to the degree to which the military units are prepared to execute the tasks required by the military operation. An assessment of readiness includes a look at the manning, equipment status and training status of the force relative to the operation at hand. The readiness of the force has an inverse relationship with the probability of military failure; all other factors held constant, an increase in the readiness of the force leads to a decrease in the probability of military failure.

c. The Complexity of the Military Operation

The complexity of the military operation refers to the number of military tasks that are required to be accomplished by separate units operating simultaneously, each task being necessary but not sufficient to accomplish the military objective. The complexity of the military operation has a direct relationship with the probability of military failure; all

other factors held constant, an increase in the complexity of the military operation leads to an increase in the probability of military failure.

d. The Delegation of Control

The delegation of control refers to the degree to which the military commander has autonomous control over the application of force in a military operation. The delegation of control has an inverse relationship with the probability of military failure; all other factors held constant, an increase in the delegation of control leads to a decrease in the probability of military failure.

C. THE RISK OF POLITICAL FAILURE

1. Components

The risk of political failure is the product of the probability of political failure and the cost of political failure. The probability of political failure is simply the likelihood that a military operation's application of force and attainment of the military objective will fail to achieve the political objective. The costs of political failure are the political consequences incurred by a state as a result of a failure to achieve the political objective. Figure 7 illustrates this relationship.

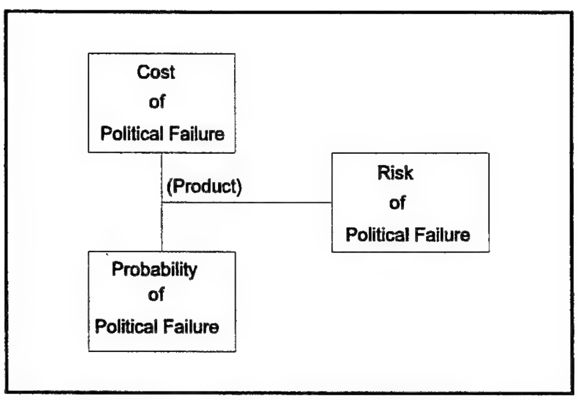

Figure 7. The Risk of Political Failure

2. Factors Affecting the Cost of Political Failure

As in the case of military failure, the principal determinants of the cost of political failure are domestic and international politics. The influence of domestic politics is determined by the degree to which a state's domestic audience is sensitive to a military operation and has the means to respond to a political failure. Likewise, the degree to which international politics influence the cost of political failure is determined by the international audiences' sensitivity to a state's military operation and their response capability. These variables have a direct relationship with the cost of a political failure in that an increase in either the sensitivity to a military operation or the audiences' capability to respond increases the cost. Figure 8 illustrates this relationship.

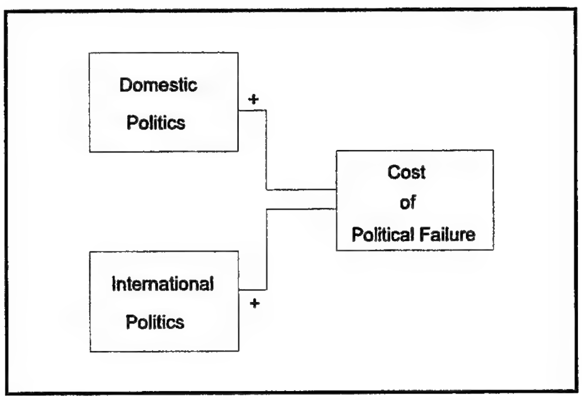

Figure 8. The Cost of Political Failure

3. Factors Affecting the Probability of Political Failure

The principal factors affecting the probability of political failure are (1) the delegation of control, (2) the complexity of the political objective, (3) the political dynamism, and (4) the linkage between the military objective and the political objective. (See Figure 9).

a. The Delegation of Control

As before, the delegation of control refers to the degree to which the military commander has autonomous control over the application of force in a military operation. In

this case, however, the delegation of control has an direct relationship with the dependent variable; all other factors held constant, an increase in the delegation of control leads to an increase in the probability of political failure.

b. The Complexity of the Political Objectives

The complexity of the political objective refers to the degree to which the desired end-state depends on numerous responses by separate individuals or states, each response being necessary but not sufficient for the attainment of the political objective. The complexity of the political objective has an direct relationship with the probability of political failure; all other factors held constant, an increase in the complexity of the political objective leads to an increase in the probability of political failure.

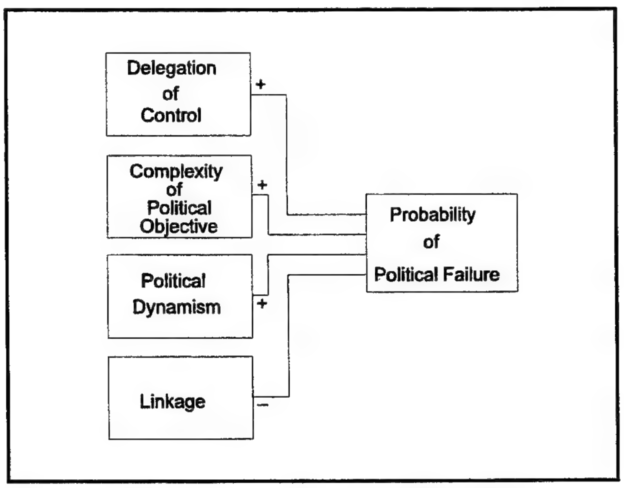

Figure 9. The Probability of Political Failure

c. The Political Dynamism

The political dynamism refers to the degree to which the political environment varies with time. A highly dynamic political environment requires constant assessment and possible adjustment of the political objective; a static environment, on the other hand, requires little such attention. The political dynamism has an direct relationship with the probability of political failure; all other factors held constant, an increase in the political dynamism leads to an increase in the probability of political failure.

d. Linkage between Military and Political Objectives

Linkage refers to the degree to which the military objective of an operation directly coincides with the political objective. An example of high linkage is a show of force operation; the political objective, demonstrating one's military capability, directly corresponds to the application of force and the military objective. An attempt to influence another state's internal affairs through the employment of covert military operations, on the other hand, is an example of low linkage. Linkage has an inverse relationship with the probability of political failure; all other factors held constant, an increase in linkage leads to a decrease in the probability of political failure.

D. A FRAMEWORK FOR ANALYZING RISK IN MILITARY OPERATIONS

The preceding sections of this chapter have identified the components of risk in military operations and the key variables that influence them. In Figure 10, the "pieces" have been "put together" and the consolidated framework is illustrated.

1. Usefulness of the Framework

The framework presented in Figure 10 permits the systematic analysis of risk in a military operation. An operation's aggregate risk has two components, military risk and political risk, each of which is a cost-weighted probability. Evaluation of the key variables allows for an estimation of each component's cost-weighted probability and the direct comparison of military risk and political risk in a military operation. The framework also enables one to assess the impact of changes in the situation on the levels of risk. A decrease in the complexity of the operation, for instance, decreases the probability of military failure but has no impact on the probability of political failure. The risk of political failure, therefore, remains constant, but the risk of military failure and the aggregate risk of the operation both decrease.

2. Delegation of Control as the Central Variable

Further examination of the framework highlights a central role played by the delegation of control in determining the risk of a military operation. Once an operation is

planned and forces assigned, all the key variables can be viewed as "constants" except for the delegation of control. It alone remains as a variable under the influence of a political leader throughout a military operation. As such, it has the potential to become an important tool in managing the levels of risk.

Additionally, the delegation of control is the only key variable that simultaneously effects both components of risk. It does so, however, with opposite results. An increase in the delegation of control to the military commander decreases the probability and risk of military failure, but at the same time, increases the probability and risk of political failure. But what is the net impact on the military operation's aggregate risk? Does it decrease, remain the same, or increase? The conceptual framework presented in this chapter cannot answer these questions.

3. The Need for a Mathematical Model

The preceding discussion highlights the need for a more precise understanding of risk in military operations. While the conceptual framework provides a good model for organizing and understanding the variables affecting risk, it does little to illustrate the dynamics of their causal relationships in anything more than general terms. A quantitative model, rather than a qualitative one, is required for this type of detailed analysis; such a model is the subject of Chapter III.

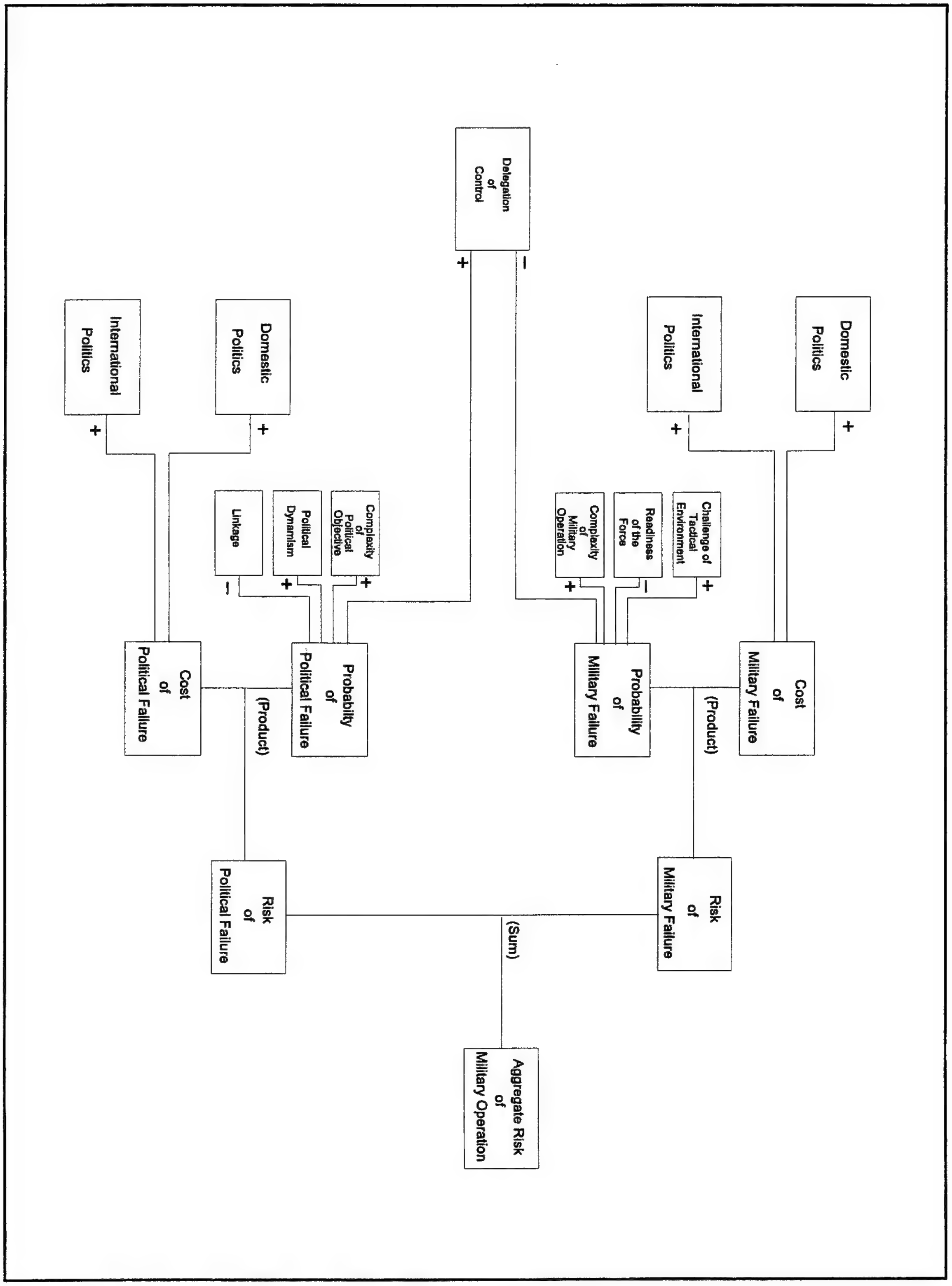

Figure 10. Framework for Analyzing Risk in Military Operations

III. OPERATIONALIZING RISK: A FORMAL MODEL

The analytic framework developed in Chapter II offers a practical means for organizing and understanding the key variables influencing risk in military operations. As previously discussed, however, understanding the relationships in only general terms limits the usefulness of the framework to providing only general observations and explanations. A more detailed and precise understanding of the framework's causal relationships is required for true explanatory and predictive power.

The purpose of this chapter is to present a mathematical model derived from the analytic framework developed in Chapter II. While the use of quantitative methods for political and behavioral analysis is often criticized, mathematical models do offer significant benefits. They provide a rigorous logic to the relationships among variables and a systematic method of predicting their interactions. Additionally, mathematical models and the graphical representation of their dynamics often allow for insights to be made and conclusions drawn that are not intuitively apparent.[1]

This chapter is an attempt to shed light on and increase the understanding of risk dynamics in military operations through the use of mathematical modeling techniques. The validity of such techniques rests primarily on the assumptions made in correlating the mathematical model with the actual phenomenon; the more logical the assumptions, the more trustworthy the resulting conclusions. Special attention, therefore, has been placed on careful explanations and justifications for the assumptions used in this model. The resulting mathematical model provides very interesting insight into the dynamics of risk in military operations and, as shown in Chapter IV, leads to a useful approach for enhancing the

[1]For an excellent critique of the usefulness and limitations of quantitative methods applied to political and behavioral issues, see Ralph E. Strauch, "A Critical Assessment of Quantitative Methodology as a Policy Analysis Tool," in *Mathematics of Conflict*, ed. Martin Shubik, (Amsterdam: Elsevier Science Publishers, 1983), 29-54.

likelihood of success: risk minimization through the optimization of command and control arrangements.

A. DERIVATION OF THE RISK EQUATION

As discussed in the previous chapter, a military operation's aggregate risk of failure can be thought of as having two components: the risk of military failure and the risk of political failure. If R_A represents the aggregate risk of a military operation, R_{MF} the risk of military failure, and R_{PF} the risk of political failure, then the relationship between the aggregate risk and its components can be represented by:

$$R_A = R_{MF} + R_{PF} \tag{1}$$

It is important to note that the risk of political failure is actually the risk of political failure *given* a military success, and that if there is a military failure, then there is necessarily a political failure. (See the Appendix for a proof of the additive nature of risk in this situation) As in the analytic framework, this relationship provides the basic structure for the mathematical model.

Consistent with the definitions presented in Chapter II, the risk of an event can be conceptualized as the product of the cost associated with the event and the probability of the event occurring. The risk of military failure, therefore, is the product of the cost of military failure and the probability of military failure. If C_{MF} represents the cost of military failure, and P_{MF} the probability of military failure, then the risk of military failure can be represented by:

$$R_{MF} = C_{MF}\,P_{MF} \tag{2}$$

Similarly, the risk of political failure, R_{PF} , can be expressed as:

$$R_{PF} = C_{PF}\,P_{PF} \tag{3}$$

By making the appropriate substitutions, the original equation can now be expressed as the sum of two cost-weighted probabilities:

$$R_A = C_{MF}\, P_{MF} + C_{PF}\, P_{PF} \tag{4}$$

The relationships suggested by this equation are depicted in Figure 11 and are consistent with the analytic framework presented in Chapter II. The following sections develop a mathematical framework for operationalizing the military and political components of this equation.

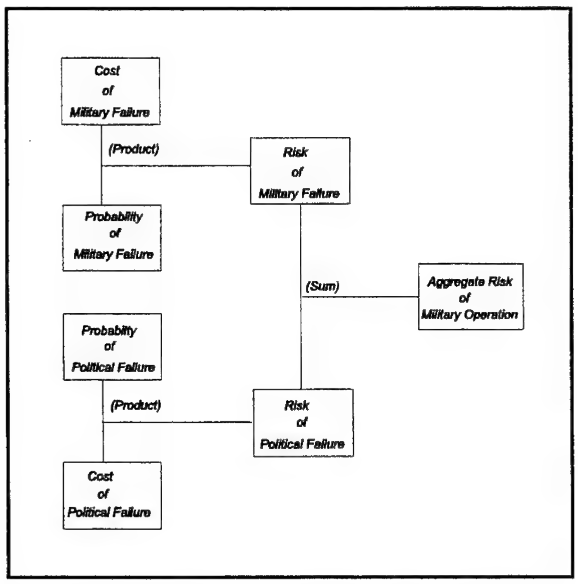

Figure 11. Components of the Risk Equation

B. THE MILITARY COMPONENT

1. General Equation for Risk of Military Failure

As previously discussed, the risk of military failure is the product of the cost of military failure and the probability of military failure:

$$R_{MF} = C_{MF}\, P_{MF} \tag{5}$$

The cost of a military failure is a function of the domestic and international politics:

$$C_{MF} = f\,(Domestic\ \ Politics,\ Intl\ \ Politics) \qquad \textbf{(6)}$$

The probability of a military failure is a function of the challenge of the tactical environment, the readiness of the force, the complexity of the operation, and the delegation of control:

$$P_{MF} = f\,(Challenge,\ Readiness,\ Complexity,\ Control) \qquad \textbf{(7)}$$

The general equation for the risk of military failure can be expressed, therefore, as the product of these two functions:

$$R_{MF} = f\,(Domestic\ Politics,\ Intl\ Politics)\, f\,(Challenge,\ Readiness,\ Complexity,\ Control) \qquad \textbf{(8)}$$

2. Risk of Military Failure as a Function of the Delegation of Control

The next step in the formulation of the mathematical model involves modifying the general equation for the risk of military failure into one expressed as a function of the delegation of control. The delegation of control is selected as the independent variable for two reasons. As discussed in Chapter II, the delegation of control is the only key variable that simultaneously effects both components of risk. Additionally, once an operation is planned and forces assigned, all the key variables can be considered constants except for the delegation of control. It alone remains as a variable under the influence of a political leader throughout the execution of a military operation. As such, it has the potential to become a mechanism for managing the levels of risks.

In order to modify the general equation into one expressed in terms of the delegation of control, the model presented here assumes a static perspective. At any particular point in time during a military operation, all the key variables (except the delegation of control) can be considered as established quantities and, therefore, as constants. The cost of military failure, a function of domestic and international politics, is independent of the delegation of control; its value will not vary with changes in the delegation of control and, therefore, can

be correctly expressed as the constant C_{MF}. The probability of military failure becomes a function of the delegation of control, $f\,(Control)$. The other key variables affecting the probability of military failure (i.e., the challenge of the tactical environment, the readiness of the force, and the complexity of the military operation) are considered constants whose values determine the nature of this functional relationship. In other words, they define the way in which the probability of military failure will vary with the delegation of control. The risk of military failure can now be expressed as the product of a cost constant and a probability function:

$$R_{MF} = C_{MF}\,f\,(Control) \qquad \textbf{(9)}$$

3. Probability of Military Failure as a Function of Delegation of Control

As discussed, the probability of military failure can be viewed as a function of the delegation of control. In such an approach, the other key variables previously identified as affecting the probability of military failure (i.e., the challenge of the tactical environment, the readiness of the force, and the complexity of the military operation) become constants whose values determine the nature of this functional relationship. The following sections establish the baseline functional relationship between the probability of military failure and the delegation of control, and illustrate the effects of the other key variables on this relationship.

a. Baseline Function

It was established in Chapter II that the delegation of control has an inverse relationship with the probability of military failure; the greater the delegation of control, the lower the probability of military failure. In mathematical terms, such a relationship can be expressed most simply as a downward sloping, linear function. The probability of military failure as a function of the delegation of control, then, can be modeled by the equation:

$$P_{MF} = f\,(Control) = 1 - D_C \qquad \textbf{(10)}$$

where D_C is the delegation of control expressed as a real number, $0 < D_C < 1$, and represents the proportion of autonomous control delegated from the political leader to the military commander. This equation will be used to represent the baseline functional relationship between the probability of military failure and the delegation of control, and is graphically illustrated in Figure 12.

b. Effect of Variable "Challenge of the Tactical Environment"

At any point in time during the execution of a military operation, the challenge presented by the tactical environment can be assessed as "high", "neutral" or "low". A tactical environment that presents a neutral challenge is defined as a situation that had been envisioned and trained for by the military force and for which the force has the required capabilities to operate effectively. A highly challenging tactical environment, on the other hand, presents a situation for which the military force is ill-prepared. While a force

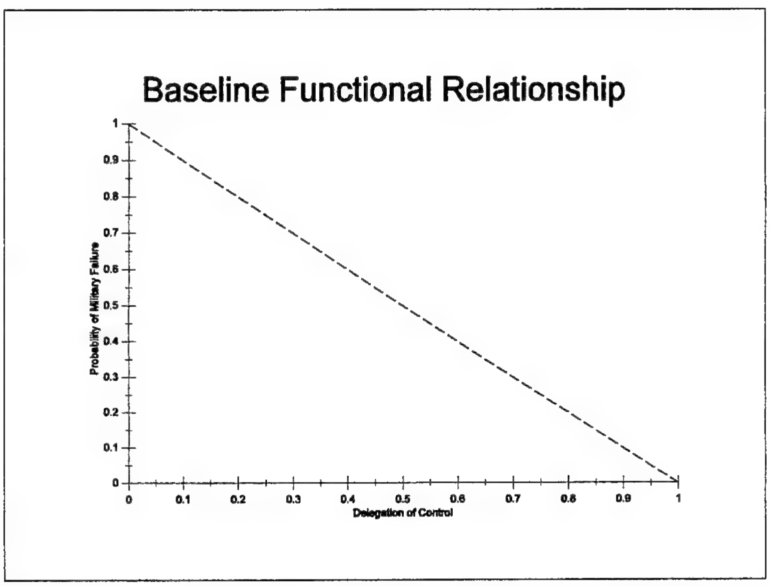

Figure 12. Probability of Military Failure as a Function of Delegation of Control

may plan for a highly challenging tactical environment, it lacks the capability to operate at peak effectiveness in such a situation. A tactical environment for which the military force

is exceptionally well prepared and poses few obstacles is considered to present a low level of challenge.

Based on these definitions, one can conclude that a neutral level of challenge presented by the tactical environment would have no effect on a military operation's probability of military failure or the probability's baseline functional relationship with the delegation of control. Because the military force is adequately prepared for the situation at hand, introducing a tactical environment with a neutral level of challenge places no new demands on the military commander. This is not the case, however, in a highly challenging environment.

A highly challenging environment affects the probability of military failure in two ways. First, it makes it more difficult for the military commander to attain the military objective, regardless of his level of control. Thus, the probability of failure is increased at each and every level of delegation; such an increase is reflected in an uniform shift upward of the baseline curve shown in Figure 12.

The second effect is less intuitive: a highly challenging tactical environment changes the *way* in which the probability will *vary* with marginal increases in the delegation of control. The baseline functional relationship reflects a constant marginal rate of change; each unit increase in the delegation of control results in a uniform decrease in the probability of military failure. In a highly challenging tactical situation, however, a unit increase in the delegation of control at the low end of the scale is of less utility to the military commander than a similar increase at the high end of the scale. This increasing marginal utility of control is due to the amount of control required by a military commander to accomplish the sub-tasks of an operation in a highly challenging environment. Each sub-task, even the most basic, is more difficult to accomplish and requires more control exercised by the military commander to ensure its success. A unit increase in the delegation of control at the low end of the scale, therefore, does assist the military commander in his ability to execute the operation but does not significantly decrease the probability of military failure. Similar

increases further up the scale, on the other hand, have greater utility to the military commander because each marginal increase in control results in an increasing number of sub-tasks that can be successfully accomplished. The result is that a unit increase in the delegation of control at the high end of the scale significantly decreases the probability of military failure.

Incorporating a tactical environment with a high level of challenge into the model requires that the baseline function be modified to represent the uniform shift upward and the increasing marginal utility of control to the military commander. These modifications are reflected in the function,

$$P_{MF} = f\,(Control) = 1 - (D_C)^2 + \beta_1 \qquad \textbf{(11)}$$

which is graphically displayed in Figure 13. This equation captures both effects a highly challenging tactical environment has on the baseline functional relationship. The first effect, a shift upward, is reflected in the term β_1, which represents a subjective assessment of the degree to which the challenge presented by the tactical environment exceeds the baseline, or neutral, level of challenge.[2] The curve shown in Figure 13 assumes a β_1 of 0.1. Raising the independent variable D_C to a power reflects the second effect. It gives the equation an increasing negative slope that appropriately represents the increasing marginal utility of control to a military commander in a highly challenging tactical environment. Note that in this example, for values of $D_C < 0.3$, the solution of the function is greater than 1. Since a probability cannot be greater than 1 or less the 0, the model assigns a value of 1 to functional solutions greater than 1, and a value of 0 to functional solutions less than 0.

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[2]The term β_1 is assessed in terms of probability; it reflects the change in the probability of failure due to the key variable's variance from the norm (or neutral level). In Figure 13, the effect of β_1 is clearly evident at D_C=1. In the baseline functional relationship, the probability of military failure at this level of delegation is 0. In a highly challenging tactical environment, the probability shifts to 0.1. This increase is β_1. The subscript is needed because additional variables that shift the function will be discussed.

This same line of reasoning can be used to infer the effects of a tactical environment with a low level of challenge on the baseline functional relationship. Introducing a tactical environment with a low level of challenge also has two effects. First, such an environment decreases the probability of failure at every level of delegation; this results in a uniform shift downward of the baseline curve. Second, a low level of challenge creates a situation in which the military commander experiences decreasing marginal utility of control. In such an environment, the sub-tasks which comprise the military objective are more easily accomplished and require less control to ensure their success. A unit increase in control at the low end of the scale, therefore, brings about greater "dividends" than a corresponding increase at the high end of the scale. Decreases in the probability of military failure, therefore, should be greater at the low end of the delegation scale than at the high end. Such a relationship can be represented by the equation:

$$P_{MF} = f(Control) = 1 - \sqrt{D_C} - \beta_1 \qquad \textbf{(12)}$$

which is graphically illustrated in Figure 14. This equation captures both effects that a tactical environment with a low level of challenge has on the baseline functional relationship. The first effect, a uniform shift downward, is reflected in the term β_1, which represents a subjective assessment of the degree to which the challenge presented by the tactical environment is less than the baseline, or neutral, level of challenge. The curve shown in Figure 14 assumes a β_1 of 0.1. Taking the square root of the independent variable D_C reflects the second effect. It gives the equation an decreasing negative slope that appropriately represents the decreasing marginal utility of control to a military commander in a tactical environment with a low level of challenge.

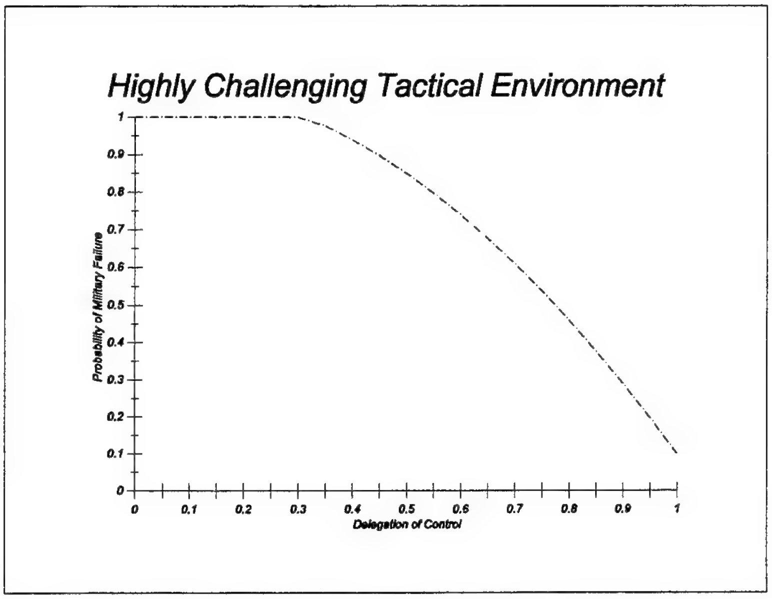

Figure 13. Probability of Military Failure as a Function of Delegation of Control in a Highly Challenging Tactical Environment

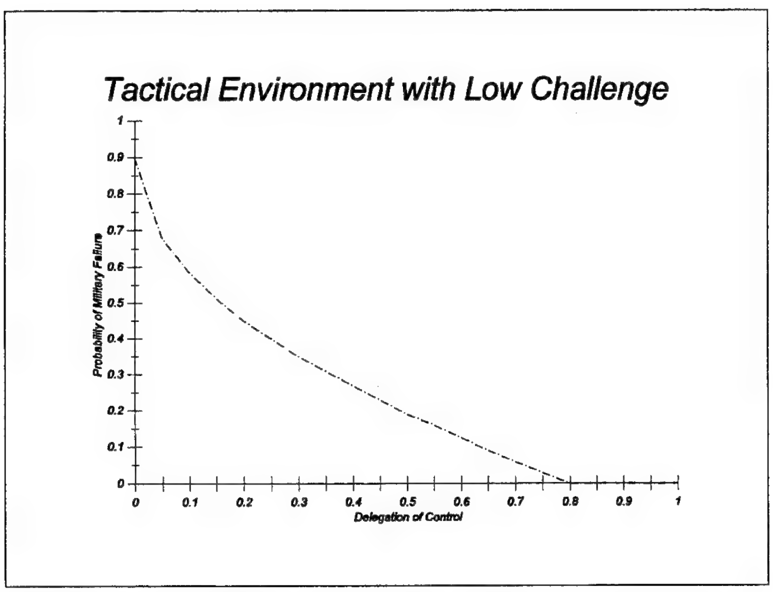

Figure 14. Probability of Military Failure as a Function of Delegation of Control in a Tactical Environment with a Low Level of Challenge

c. Effect of Variable "Readiness of the Force"

Like the variable "Challenge of the Tactical Environment," the readiness of the force employed in an operation can be assessed as high, neutral or low. A neutral level of readiness is used here to denote military units that are adequately prepared for the operational tasks and sub-tasks required by the military operation.[3] It follows that a high level of readiness denotes a force that is exceptionally well-prepared for the operation at hand, while a low level of readiness indicates military units that are poorly rehearsed in the required operational skills.

As before, introducing a neutral level of readiness has no effect on an operation's probability of military failure or the probability's baseline functional relationship with the delegation of control. A high level of readiness, however, decreases the overall probability of military failure and alters the linear baseline functional relationship to one that reflects decreasing marginal changes. Exceptionally well-trained troops are able to accomplish the same operational tasks and sub-tasks with less control and direction than average troops. As a result, a military commander derives more benefit from a unit increase in control at the low end of the scale than he does from the high end. These effects can be modeled by the equation:

$$P_{MF} = f(Control) = 1 - \sqrt{D_C} - \beta_2 \qquad \textbf{(13)}$$

Here, β_2 is used to represent a subjective assessment of the degree to which the readiness of the troops exceeds the baseline, or neutral, level of readiness. As before, subtracting the term β_2 shifts the baseline curve downward while taking the square root of the independent

[3]It is useful to underscore the distinction between the measure used here and the measure used for the "challenge of the tactical environment." The "readiness of the force" is measured against the skills required by the operation itself, regardless of the environment it is being executed in. The "challenge of the tactical environment," on the other hand, is measured against the skills required to operate in the existing tactical environment, regardless of the type operation being conducted.

variable modifies the curve to reflect the decreasing marginal utility of control to the military commander.

As would be expected, a low level of readiness has the opposite effects on the probability of military failure and its functional relationship with the delegation of control. In addition to raising the overall probability of failure, poorly prepared military units require the military commander exercise more control than normal to accomplish operational tasks and sub-tasks. Increases in control at the low end of the scale, therefore, do not provide much utility to the military commander. Similar increases at the high end of the control scale, however, increasingly provide the requisite level of control and, as a result, begin to significantly decrease the probability of military failure. If β_2 is used to represent a subjective assessment of the degree to which the readiness of the troops is less than the baseline, or neutral, level of readiness, these effects can be modeled by the equation:

$$P_{MF} = f(Control) = 1 - (D_C)^2 + \beta_2 \tag{14}$$

d. Effect of Variable "Complexity of the Operation"

Like the previous variables, the complexity of a military operation can be assessed as high, neutral or low. Neutral complexity is used here to denote a military operation in which the *number* of tasks and sub-tasks required to be performed are within the capabilities of the assigned forces. An excessive number of tasks is indicative of an operation with high complexity, while a small number of tasks, well within the operational capabilities of the assigned force is representative of a low level of complexity.

As discussed in Chapter II, the complexity of the operation has a direct relationship with the probability of military failure. Assuming a neutral level of complexity has no effect on the baseline functional relationship, a high level of complexity would result not only in an overall increase in the probability but also a shift from the baseline's linear relationship to one that displays increasing marginal changes. Like a highly challenging tactical environment, a highly complex operation necessitates an increased amount of control

exercised by the military commander to result in improved operational efficiency. A unit increase at the low end of the scale does have much utility to a military commander in a highly complex operation; the probability of military failure, therefore, is not significantly affected at the low end of the scale. The same unit increase at the high end of the scale, however, increasingly provides the military commander with the level of control required for success in complex operations. As before, if β_3 is used to represent a subjective assessment of the degree to which the complexity of the operation exceeds the baseline, or neutral, level of complexity, then both of the effects of a complex operation can be mathematically represented by the equation:

$$P_{MF} = f\,(Control) = 1 - (D_C)^2 + \beta_3 \tag{15}$$

Inverse relationships hold true for military operations with low levels of complexity. The overall probability of military failure decreases and the functional relationship shifts to reflect the decreasing marginal utility of control to a military commander in such a situation. These effects can be expressed by the equation:

$$P_{MF} = f(Control) = 1 - \sqrt{D_C} - \beta_3 \tag{16}$$

where β_3 is a subjective assessment of the degree to which the complexity of the operation is less than the baseline, or neutral, level of complexity.

e. Net Effect of Variables on Baseline Equation

The preceding sections have discussed the individual effects of each variable on the functional relationship between the probability of military failure and the delegation of control. The following paragraphs will address how the model incorporates the cumulative effect of these variables.

In an effort to keep the model as simple as possible, no attempt has been made to prioritize the relative significance of the variables. In other words, the model assumes each

variable's relative influence on the baseline functional relationship is the same as the others. This approach allows for the direct comparison of each variable's effects.

An analysis of the functions used to represent the various effects of the variables on the baseline relationship between the probability of military failure and the delegation of control reveals that they can be expressed in the following generalized form:

$$P_{MF} = f(Control) = 1 - (D_C)^{\alpha} + \beta \tag{17}$$

where α represents the net effect on the marginal rate of change (increasing or decreasing) and β represents the net effect of uniform shifts (upward or downward). In the following paragraphs, an application of this portion of the model is used to demonstrate how α and β are assessed and calculated.

The first step in using the generalized function is to evaluate the key variables affecting the probability of military failure (the challenge of the tactical environment, the readiness of the force, and the complexity of the operation). Each variable is assessed at either a high, neutral or low level and its effect on the marginal rate of change (i.e., whether it tends to increase or decrease the marginal rate of change) is noted. In addition, variables assessed as high or low are assigned a β which represents an assessment (in terms of its effect on the probability of military failure) of the degree to which that variable differs from its baseline, or neutral, value. These βs are assigned a positive value for variables whose level increases the probability of military failure, a negative value for variables whose level decreases the probability of military failure, and a value of 0 for variables assessed at a neutral level.

The term α in the generalized equation is determined by the formula:

$$\alpha = \frac{1 + I}{1 + D} \tag{18}$$

where I = [the number of variables that increase the marginal rate of change], and

D = [the number of variables that decrease the marginal rate of change].[4] The term β in the generalized equation is determined by the formula:

$$\beta = \sum_{i=1}^{3} \beta_i \tag{19}$$

Where β_i is the beta assigned to each key variable. The following example illustrates the mechanics of calculating these terms.

In this example, the challenge presented by the tactical environment and the complexity of the operation are both assessed as neutral, but the readiness of the troops is assessed as high, with a β= -0.1 (a high level of readiness decreases the risk of military failure, therefore β is given a negative value). Only the variable readiness has an effect on the marginal rate of change (decreasing); the variables assessed at neutral levels have no effect on the marginal rate of change. The calculation of α yields:

$$\alpha = \frac{1 + I}{1 + D} = \frac{1 + 0}{1 + 1} = 1/2 \tag{20}$$

The calculation of β yields:

$$\beta = \sum_{i=1}^{3} \beta_i = [(0.0) + (0.0) + (-0.1)] = -0.1 \tag{21}$$

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[4]There is no rigorous mathematical basis for this formulation of α; rather, the formula used here is the simplest expression that captures the theoretical shifts envisioned in the risk curves.

Thus, the function that best models the probability of military failure as a function of the delegation of control for this example operation is:

$$P_{MF} = 1 - (D_C)^{\alpha} + \beta \qquad \textbf{(22)}$$

$$P_{MF} = 1 - (D_C)^{\frac{1}{2}} - 0.1 \qquad \textbf{(23)}$$

$$P_{MF} = 0.9 - \sqrt{D_C} \qquad \textbf{(24)}$$

By assessing the level of each variable for a given military operation, noting its influence on the marginal rate of change, and evaluating the terms α and β, one can use the generalized equation to determine the function that best models the probability of military failure as a function of the delegation of control for a given operation. Since there are three variables and three levels of assessment for each variable, 27 permutations are possible within this component of the model. A summary of each possible combination of variables and the resulting αs and βs is shown in Table 1. Variables assessed as high or low are assumed to have a $\beta = 0.1$, (+/-, as appropriate).

Level of Challenge	Readiness of the Force	Level of Complexity	α	β
Neutral	Neutral	Neutral	1	0.0
Neutral	Neutral	Low	1/2	-0.1
Neutral	Neutral	High	2	0.1
Neutral	High	Neutral	1/2	-0.1
Neutral	High	Low	1/3	-0.2
Neutral	High	High	1	0.0
Neutral	Low	Neutral	2	0.1
Neutral	Low	Low	1	0.0
Neutral	Low	High	3	0.2
Low	Neutral	Neutral	1/2	-0.1
Low	Neutral	Low	1/3	-0.2
Low	Neutral	High	1	0.0
Low	High	Neutral	1/3	-0.2
Low	High	Low	1/4	-0.3
Low	High	High	2/3	-0.1
Low	Low	Neutral	1	0.0
Low	Low	Low	2/3	-0.1
Low	Low	High	3/2	0.1
High	Neutral	Neutral	2	0.1
High	Neutral	Low	1	0.0
High	Neutral	High	3	0.2
High	High	Neutral	1	0
High	High	Low	2/3	-0.1
High	High	High	3/2	0.1
High	Low	Neutral	3	0.2
High	Low	Low	3/2	0.1
High	Low	High	4	0.3

Table 1. Permutations of the Variables Effecting the Probability of Military Failure and the Resulting Values of α and β

C. THE POLITICAL COMPONENT

1. General Equation for Risk of Political Failure

The risk of political failure is the product of the cost of political failure and the probability of political failure:

$$R_{PF} = C_{PF}\, P_{PF} \tag{25}$$

The cost of a political failure is a function of the domestic and international politics:

$$C_{PF} = f\,(\textit{Domestic Politics, Intl Politics}) \tag{26}$$

The probability of a political failure is a function of the delegation of control, the complexity of the political objective, the dynamism of the political environment, and the operation's political linkage:

$$P_{PF} = f\,(\textit{Control, Complexity, Dynamism, Linkage}) \tag{27}$$

The general equation for the risk of political failure, therefore, can be expressed as a product of these two functions:

$$R_{PF} = f\,(\textit{Domestic Politics, Intl Politics})\, f\,(\textit{Control, Complexity, Dynamism, Linkage}) \tag{28}$$

2. Risk of Political Failure as a Function of the Delegation of Control

As in the case of military failure, the next step in developing the mathematical model involves modifying the general equation for the risk of political failure into one that is a function of the delegation of control. By again taking a static approach, all the key variables (except the delegation of control) in the model can be considered as established quantities and, therefore, as constants.

The cost of political failure, a function of domestic and international politics, is independent of the delegation of control; its value will not vary with changes in the delegation of control and, therefore, can be correctly expressed as the constant C_{PF}. The

probability of political failure is expressed simply as a function of the delegation of control, $f\,(Control)$. The other variables affecting the probability of political failure (i.e., the complexity of the political objective, the political dynamism, and the linkage) are considered constants whose values determine the nature of this functional relationship. In other words, they define the way in which the probability of political failure will vary with the delegation of control. The risk of political failure can now be expressed as a function of the delegation of control:

$$R_{PF} = C_{PF}\,f\,(Control) \qquad \textbf{(29)}$$

3. Probability of Political Failure as a Function of Delegation of Control

a. Baseline Function

As discussed in Chapter II, the probability of political failure has an direct relationship with the delegation of control; in general, the greater the delegation of control, the greater the probability of political failure. The more control a political leader delegates to a military commander, the greater the chance of a disconnect between the military means used to attain the military objective and the overall political objective. In mathematical terms, such a relationship can be expressed most simply as a upward sloping, linear function. The probability of political failure as a function of the delegation of control, then, can be modeled by the equation:

$$P_{PF} = f\,(Control) = D_C \qquad \textbf{(30)}$$

This equation will be used to represent the baseline functional relationship between the probability of political failure and the delegation of control, and is graphically illustrated in Figure 15.

Following the methodology used in the preceding sections on the military component of the risk equation, the next paragraphs address the influence of the key variables affecting the political component of the model. The distinctions between high, neutral and low levels

of each key variable will be discussed and their effects on the baseline functional relationship will be examined. A summary of all the possible combinations of these variables will then be presented along with a discussion of how the model incorporates their net effect on the baseline relationship.

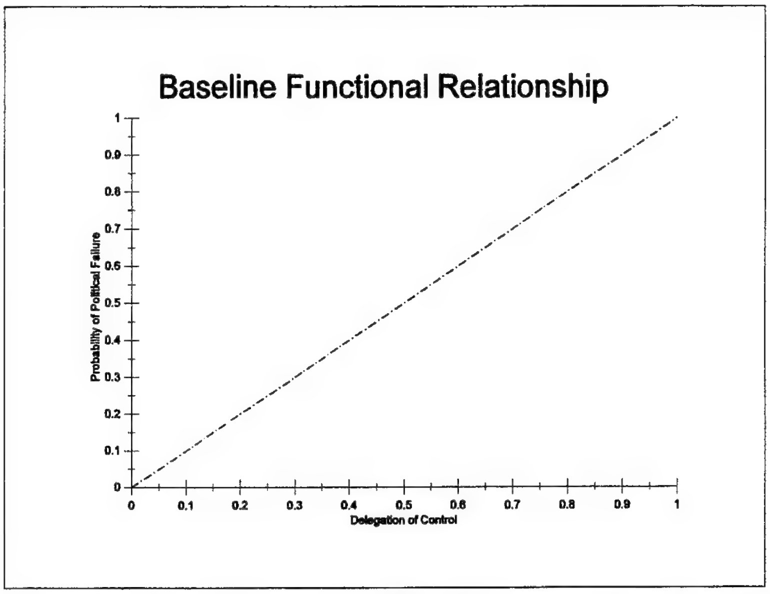

Figure 15. Probability of Political Failure as a Function of Delegation of Control

b. Effect of Variable "Complexity of the Political Objective"

As defined in Chapter II, the complexity of the political objective refers to the degree to which the desired end-state depends on inducing appropriate responses from a number of separate individuals or states, each response being necessary but not sufficient for the attainment of the political objective. A neutral level of complexity exists in the political objective when the number and type of actors a political leader must deal with are within the capability of his diplomatic apparatus. A high level of complexity, then, is indicative of a situation in which the number or type of external actors create problems in diplomatic communications and coordination. A state dealing with underground, sub-state actors, for instance, has great difficulty in establishing an effective means of communications for negotiations or diplomatic signalling. A low level of complexity, on the other hand, exists

when a state has very effective means of communicating and coordinating with the required external actors.

A high level of complexity in the political objective has two effects on the probability of political failure. First, the increased complexity makes the political objective more difficult to attain, regardless of the level of control retained by the political leader. This results in a uniform shift upward in the baseline functional relationship. Second, a high level of complexity changes the way in which the probability of political failure will vary with the delegation of control. It dictates that the political leader must retain a high degree of control in order to prevent a decoupling of the military and political objectives. The probability of political failure, then, has a tendency to rise quickly as the political leader begins to delegate control to the miliary commander. Further increases in the delegation of control, however, result in smaller marginal changes. Since the effective range of control required by the political commander has already been passed, the additional delegation of control has decreasing influence on the probability of failure. A high level of complexity in the political objective, therefore, has the effect of modifying the linear baseline relationship to one that exhibits decreasing marginal changes. These effects can be mathematically modeled with the function:

$$P_{PF} = f(Control) = \sqrt{D_C} + \gamma_1 \qquad \textbf{(31)}$$

which is graphically shown in Figure 16. This equation captures both effects a highly complex political objective has on the baseline functional relationship. The first effect, a shift upward, is reflected in the term γ_1, which represents a subjective assessment of the degree to which the political objective's complexity exceeds the baseline, or neutral, level of complexity. The curve shown in Figure 16 assumes a γ_1 of 0.1. Taking the square root of the independent variable D_C reflects the second effect. It gives the curve a decreasing positive slope that appropriately represents the decreasing marginal changes in the probability of failure as control is delegated from a political leader to a military commander.

Note that in this example, for values of $D_C > 0.8$, the solution of the function is greater than 1. Since a probability cannot be greater than 1 or less the 0, the model assigns a value of 1 to functional solutions greater than 1, and a value of 0 to functional solutions less than 0.

A low level of complexity in the political objective has the opposite effects. First, a simple political objective is easier to attain regardless of the political leader's level of control. This results in a uniform shift downward in the baseline relationship. Additionally, if the political objective is not complex, the political leader will be well positioned to communicate and coordinate with required actors; he can, therefore afford to delegate more control to the military commander without significantly raising the probability of a political failure. Further delegation of control, however, results in increasingly larger incremental rises in the probability of failure. These two effects, the increasing marginal changes and the uniform ship downward, can be modeled by the equation:

$$P_{PF} = f(Control) = (D_C)^2 - \gamma_1 \tag{32}$$

which is also shown in Figure 16. The first effect, a shift downward, is reflected by subtracting the term γ_1, which represents a subjective assessment of the degree to which the political objective's complexity is less than the baseline, or neutral, level of complexity. The curve shown in Figure 16 assumes a γ_1 of 0.1. Squaring the independent variable D_C reflects the second effect. It gives the equation an increasing positive slope that appropriately represents the increasing marginal changes in the probability of failure as control is delegated from a political leader to a military commander.

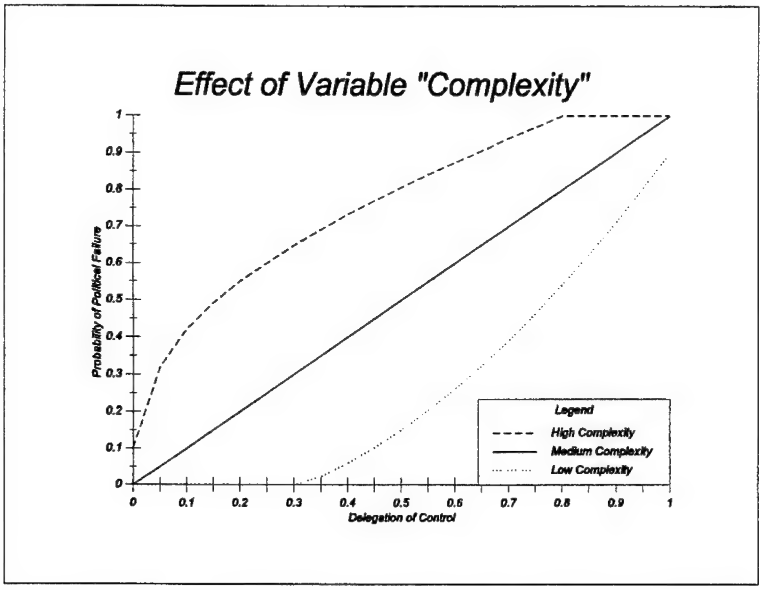

Figure 16. Effect of Variable "Complexity" on the Probability of Political Failure as a Function of Delegation of Control

c. Effect of Variable "Political Dynamism"

The political dynamism of a military operation refers to the degree to which the existing political environment varies with time. A high level of political dynamism exists in a military operation when the potential pace of diplomatic efforts and changes in the political environment strains the capability of the political leader to effectively coordinate with his military commander. Such an environment makes it more difficult for the political leader to attain the political objective, regardless of the level of control he retains. As before, this results in a uniform shift upward in the baseline relationship between probability of failure and delegation of control. Additionally, because a highly dynamic political environment requires constant assessment and possible adjustment of the political objective, the political leader must retain a high degree of control in order to prevent a disconnect and political failure. As in the previous case, the probability of political failure has a tendency to rise quickly as the political leader begins to delegate control to the miliary commander.

Further increases in the delegation of control, however, result in smaller marginal changes. Since the effective range of control required by the political commander has already been passed, the additional delegation of control has decreasing influence on the probability of failure. A high level of political dynamism, therefore, has two effects on the linear baseline relationship. These effects can be mathematically modeled with the function:

$$P_{PF} = f(Control) = \sqrt{D_C} + \gamma_2 \tag{33}$$

The first effect, a shift upward, is reflected in the term γ_2, which represents a subjective assessment of the degree to which the environment's political dynamism exceeds the baseline, or neutral, level of dynamism. Taking the square root of the independent variable D_C reflects the second effect. It gives the curve a decreasing positive slope that appropriately represents the decreasing marginal changes in the probability of failure as control is delegated from a political leader to a military commander.

A low level of dynamism has the opposite effects. The probability of a disconnect is lower in a stable political environment because the political objective does not require constant monitoring and reassessment. Since the political leader can effectively respond to changes in such a political environment, he can afford to delegate more control to the military commander without significantly raising the probability of a political failure. Further delegation of control, however, results in increasingly larger incremental rises in the probability of failure. As in the previous case, these two effects on the baseline relationship can be modeled by the equation:

$$P_{PF} = f(Control) = (D_C)^2 - \gamma_2 \tag{34}$$

The first effect, a shift downward, is reflected by subtracting the term γ_2, which represents a subjective assessment of the degree to which the environment's political dynamism is less than the baseline, or neutral, level of dynamism. Squaring the independent variable D_C reflects the second effect. It gives the equation an increasing positive slope that

appropriately represents the increasing marginal changes in the probability of failure as control is delegated from a political leader to a military commander.

d. Effect of Variable "Linkage"

Linkage refers to the degree to which the military objective of an operation coincides with the political objective. As discussed in Chapter II, a high level of linkage exists when the military and political objective are basically one in the same. As opposed to the other two variables just discussed, linkage has an inverse relationship with the probability of political failure. A high level of linkage, therefore, lowers the overall probability of political failure and allows the political leader to delegate more control to the military commander before the probability is significantly affected. As before, these two effects can be mathematically expressed by the equation:

$$P_{PF} = f(Control) = (D_C)^2 - \gamma_3 \tag{35}$$

The first effect, a shift downward, is reflected by subtracting the term γ_3, which represents a subjective assessment of the degree to which the operation's political linkage is less than the baseline, or neutral, level of linkage. Squaring the independent variable D_C reflects the second effect. It gives the equation an increasing positive slope that appropriately represents the increasing marginal changes in the probability of failure as control is delegated from a political leader to a military commander.

A low level of linkage has the opposite effect. The indirect nature of the coupling between the military and political objective raises the overall probability of political failure and requires the political leader exercise tight control over the operation to prevent political failure. As soon as the political leader begins to delegate control to the political commander, the probability of political failure rises significantly. Further delegation of control continues to increase the probability of political failure, but in decreasing incremental changes. These effects can be mathematically modeled with the equation:

$$P_{PF} = f(Control) = \sqrt{D_C} + \gamma_3 \tag{36}$$

The first effect, a shift upward, is reflected in the term $\gamma_{3,}$ which represents a subjective assessment of the degree to which the operation's political linkage exceeds the baseline, or neutral, level of linkage. Taking the square root of the independent variable D_C reflects the second effect. It gives the curve a decreasing positive slope that appropriately represents the decreasing marginal changes in the probability of failure as control is delegated from a political leader to a military commander.

e. Net Effect of Variables on Baseline Function

The cumulative effect of these key variables on the baseline functional relationship between the probability of political failure and the delegation of control is handled in exactly the same manner as before. Again, no attempt has been made to prioritize the relative significance of the variables.

An analysis of the functions used to represent the various effects of the variables on the baseline relationship between the probability of political failure and the delegation of control reveals that they can be expressed in the following generalized form:

$$P_{MF} = f(Control) = (D_C)^{\sigma} + \gamma \qquad \textbf{(37)}$$

where σ represents the net effect on the marginal rate of change (increasing or decreasing) and γ represents the net effect of uniform shifts (upward or downward). In the following paragraphs, an application of this portion of the model is used to demonstrate how σ and γ are assessed and calculated.

The first step in using the generalized function is to evaluate the key variables affecting the probability of political failure (the complexity of the political objective, the political dynamism, and the linkage). Each variable is assessed at either a high, neutral or low level and its effect on the marginal rate of change (i.e., whether it tends to increase or decrease the marginal rate of change) is noted. In addition, variables assessed as high or low are assigned a γ which represents an assessment of the degree to which that variable differs from its baseline, or neutral, value. These γs are assigned a positive value for variables

whose level increases the probability of political failure, a negative value for variables whose level decreases the probability of political failure, and a value of 0 for variables assessed at a neutral level.

The term σ in the generalized equation is determined by the formula:

$$\sigma = \frac{1 + I}{1 + D} \tag{38}$$

where I = [the number of variables that increase the marginal rate of change], and D = [the number of variables that decrease the marginal rate of change]. The term γ in the generalized equation is determined by the formula:

$$\gamma = \sum_{i=1}^{3} \gamma_i \tag{39}$$

Where γ_i is the gamma assigned to each key variable. The following example illustrates the mechanics of calculating these terms.

In this example, the complexity of the political objective and the political dynamism are assessed as low, each a with γ = -0.1 (a low level of complexity and a low level of dynamism each lowers the probability of political failure, therefore γ is given a negative value). The linkage is assessed as neutral. The low levels of the complexity and dynamism both have an effect on the marginal rate of change (increasing); because the linkage is assessed at a neutral level, it has no effect on the marginal rate of change. The calculation of σ yields:

$$\sigma = \frac{1 + I}{1 + D} = \frac{1 + 2}{1 + 0} = 3/1 = 3 \tag{40}$$

The calculation of γ yields:

$$\gamma = \sum_{i=1}^{3} \gamma_i = [(-0.1) + (-0.1) + (0.0)] = -0.2 \quad \textbf{(41)}$$

Thus, the function that best models the probability of political failure as a function of the delegation of control for this example operation is:

$$P_{PF} = (D_C)^{\sigma} + \gamma \quad \textbf{(42)}$$

$$P_{PF} = (D_C)^{3} - 0.2 \quad \textbf{(43)}$$

By assessing the level of each variable for a given military operation, noting its influence on the marginal rate of change, and evaluating the terms σ and γ, one can use the generalized equation to determine the function that best models the probability of political failure as a function of the delegation of control for a given operation.

As before, there are three variables and three levels of assessment for each variable; 27 additional permutations are possible within this component of the model. A summary of each possible combination of variables and the resulting σs and γs is shown in Table 2. Variables assessed as high or low are assumed to have a γ= 0.1 (+/-, as appropriate).

Level of Complexity	Political Dynamism	Level of Linkage	σ	γ
Neutral	Neutral	Neutral	1	0.0
Neutral	Neutral	Low	1/2	0.1
Neutral	Neutral	High	2	-0.1
Neutral	High	Neutral	1/2	0.1
Neutral	High	Low	1/3	0.2
Neutral	High	High	1	0.0
Neutral	Low	Neutral	2	-0.1
Neutral	Low	Low	1	0.0
Neutral	Low	High	3	-0.2
Low	Neutral	Neutral	2	-0.1
Low	Neutral	Low	1	0.0
Low	Neutral	High	3	-0.2
Low	High	Neutral	1	0.0
Low	High	Low	2/3	0.1
Low	High	High	3/2	-0.1
Low	Low	Neutral	3	-0.2
Low	Low	Low	3/2	-0.1
Low	Low	High	4	-0.3
High	Neutral	Neutral	1/2	0.1
High	Neutral	Low	1/3	0.2
High	Neutral	High	1	0.0
High	High	Neutral	1/3	0.2
High	High	Low	1/4	0.3
High	High	High	2/3	0.1
High	Low	Neutral	1	0.0
High	Low	Low	2/3	0.1
High	Low	High	3/2	-0.1

Table 2. Permutations of Variables Effecting the Probability of Political Failure and the Resulting Values of σ and γ

D. THE MATHEMATICAL MODEL

The preceding sections have developed the mathematical framework for describing the individual military and political components of risk in a military operation. In this section, these components are consolidated into a single model for describing an operation's aggregate risk. After explaining the methodology used for assessing and comparing the military and political costs of failure, a comprehensive example is used to illustrate the application of the entire model to a military operation.

1. The Costs of Failure

As previously discussed, the costs of military and political failure are considered constants and serve to weight the appropriate probabilities of failure. But how can one quantify such costs? What scale can be used to for their comparison? The risk model presented here avoids these difficult questions by measuring the costs *relative* to each other. In most situations, the cost of a military failure is indistinguishable from the cost of a political failure; in such a case, the model assigns a value of 1 to each cost:

$$C_{MF} = C_{PF} = 1 \tag{44}$$

In some cases, however, one cost may be judged as greater than the other. Here a subjective assessment of the relative difference between the two costs is made. For instance, if the cost of political failure is subjectively assessed as twice as great as the cost of military failure, the model would assign the following values:

$$C_{MF} = 1 \quad C_{PF} = 2 \tag{45}$$

Such an approach allows the direct comparison of the costs in a military operation without objective standards of measurement.

2. The Consolidated Model

A brief summary of the mathematical framework developed in this chapter is necessary at this point to pull together the highlights of the preceding discussions and present the consolidated model.

A military operation's aggregate risk of failure can be thought of as having two components: the risk of military failure and the risk of political failure:

$$R_A = R_{MF} + R_{PF} \tag{46}$$

The risk of an event can be conceptualized as the product of the cost associated with the event and the probability of the event occurring. The risk of military failure, therefore, is the product of the cost of military failure and the probability of military failure.

$$R_{MF} = C_{MF} \, P_{MF} \tag{47}$$

Similarly, the risk of political failure, R_{PF}, can be expressed as:

$$R_{PF} = C_{PF} \, P_{PF} \tag{48}$$

By making the appropriate substitutions, the original equation can now be expressed as the sum of two cost-weighted probabilities:

$$R_A = C_{MF} \, P_{MF} + C_{PF} \, P_{PF} \tag{49}$$

In terms of the independent variable, "the delegation of control," this equation can be written as:

$$R_A = C_{MF} \, f(Control) + C_{PF} \, f(Control) \tag{50}$$

In modifying this equation to reflect risk as a function of the delegation of control, the costs of military and political failure remain constants and are measured relative to each other. The probability of military failure becomes a function of the delegation of control; the nature

of this function is determined by an evaluation of the key variables affecting the probability of military failure (the challenge of the tactical environment, the readiness of the force, and the complexity of the operation) and assessing their net effect on the baseline functional relationship (as summarized in Table 1).

Similarly, the probability of political failure also becomes a function of the delegation of control. The nature of this function is determined by an evaluation of the key variables affecting the probability of political failure (the complexity of the political objective, the political dynamism, and the linkage) and assessing their net effect on the baseline functional relationship (as summarized in Table 2).

A hypothetical example and an application of the model illustrates these mechanics. In this example, the cost of military failure is assumed to be roughly equal to the cost of a political failure. Therefore, $C_{MF} = C_{PF} = 1$. The challenge presented by the tactical environment and the complexity of the operation are both assessed as neutral, but the readiness of the troops is assessed as high, and with a $\beta = -0.1$ (a high level of readiness will shift the baseline curve downward, therefore β is given a negative value). Only the variable readiness has an effect on the marginal rate of change (decreasing); the variables assessed at neutral levels have no effect on the marginal rate of change. Table 1 indicates that the probability of military failure as a function of the delegation of control is best expressed by the function:

$$P_{MF} = 1 - (D_C)^{\alpha} + \beta \tag{51}$$

$$P_{MF} = 1 - (D_C)^{1/2} - 0.1 \tag{52}$$

$$P_{MF} = 0.9 - \sqrt{D_C} \tag{53}$$

The complexity of the political objective and the political dynamism are assessed as low, each with a $\gamma = -0.1$ (a low level of complexity and a low level of dynamism each shifts the baseline curve downward, therefore γ is given a negative value). The linkage is assessed as neutral. The low levels of the complexity and dynamism both have an effect on the

marginal rate of change (increasing); because the linkage is assessed at a neutral level, it has no effect on the marginal rate of change. Table 2 indicates that the probability of political failure as a function of the delegation of control is best expressed by the function:

$$P_{PF} = (D_C)^{\sigma} + \gamma \tag{54}$$

$$P_{PF} = (D_C)^3 - 0.2 \tag{55}$$

Having established the values and appropriate functions for C_{MF} , C_{PF} , P_{MF} , P_{PF}, substitutions are made in the aggregate risk equation:

$$R_A = R_{MF} + R_{PF} \tag{56}$$

$$R_A = C_{MF}\, P_{MF} + C_{PF}\, P_{PF} \tag{57}$$

$$R_A = [(1)\ (0.9 - \sqrt{D_C})] + [(1)\ ((D_C)^3 - 0.2)] \tag{58}$$

$$R_A = 0.7 - \sqrt{D_C} + (D_C)^3 \tag{59}$$

The graphical representation of this aggregate risk equation and its components (risk of military failure and risk of political failure) is depicted in Figure 17. Note that the aggregate risk curve does not exactly correspond to Equation 59 for all values of D_C (i.e., when $D_C = 0.1$, Equation 59 generates an aggregate risk value of approximately 0.37 units vice the 0.55 units shown in the figure). This discrepancy is characteristic of the model and results from constraints on the probability functions embedded in the overall aggregate risk equation. Since probabilities cannot be less than 0 or greater than 1, the risk model truncates the P_{MF} and P_{PF} functions when the shift parameters, β and γ, have the effect of forcing the functions outside these limits. These truncations can result in an inconsistency between the purely mathematical formulation of the aggregate risk equation, which does not take account of the constraints on the probabilities, and the risk model's graphical representation of the aggregate risk curve.

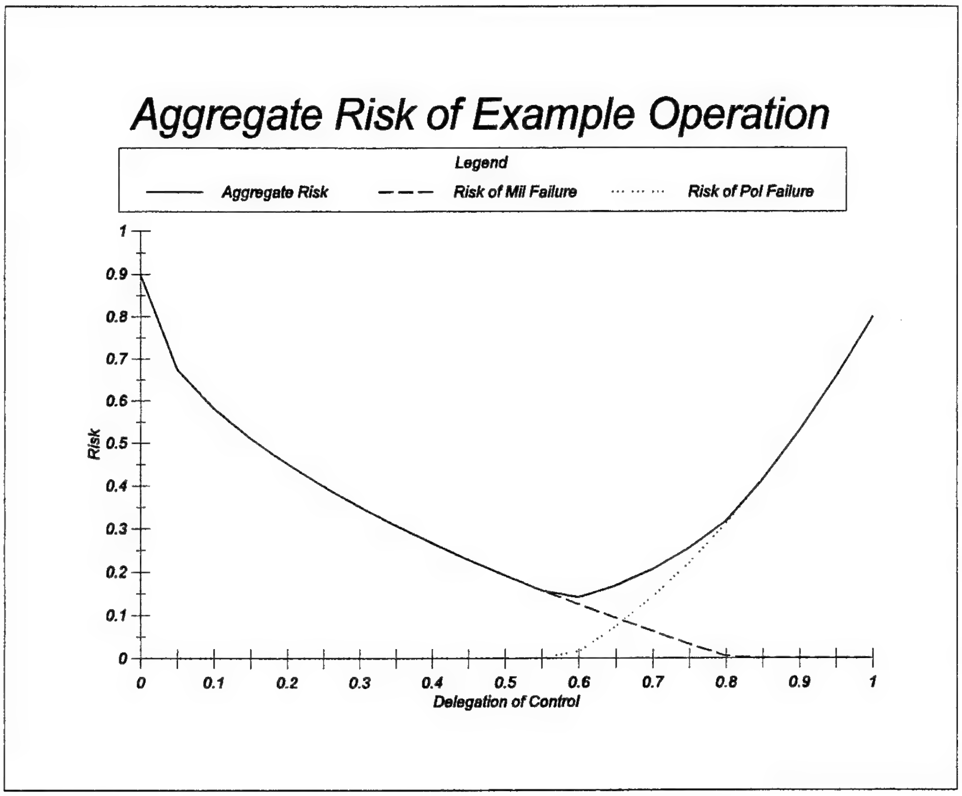

Figure 17. Example Military Operation's Aggregate Risk

The next chapter will explore the use of the mathematical model as a tool to assist in the planning of military operations. It will discuss the concept of risk management through the optimization of control, the various categories of aggregate risk solutions and the implications for command and control arrangements.

IV. MANAGING RISK: THE MODEL AS A PLANNING TOOL

The preceding chapters have systematically developed a conceptual framework and formal model for analyzing risk in military operations. The purpose of this chapter is to explore the theoretical application of the risk model as a planning tool. It begins by demonstrating how employment of the model allows a political leader to analyze the risk dynamics inherent in a given military operation and minimize risk exposure through the optimization of control. The chapter then examines the general aggregate risk solutions generated by the model, the potential types of delegation error and the resulting implications for command and control arrangements.

A. THE MODEL AS A PREDICTIVE TOOL

1. Key Assumption

A necessary assumption for the use of the risk model as a predictive tool is that a *primary* goal in any military operation is the reduction of the *overall* risk of failure. In this view, the proper focus of the senior decision-maker is the minimization of exposure to aggregate risk, rather than the reduction of either of its components (i.e., the risk of military failure or the risk of political failure). Thus, while both the military commander and the political leader are considered to be risk-adverse and are expected to desire minimum levels of their respective risks, the political leader (the senior decision-maker) is assumed to maintain a more strategic outlook toward the operation and, therefore, prefer the minimization of aggregate risk.

2. Risk Minimization through Optimization of Control

The risk model can be thought of as a tool for predicting how risk in a military operation will vary with changes in the delegation of control. As such, it provides a means for analyzing the risk dynamics of the operation and minimizing aggregate risk through the optimization of control.

As explained in the previous chapter, the first step in applying the model is to assess the levels of the key variables affecting the probability of military failure and the probability of political failure. This assessment involves a determination of the variable's level (high, neutral or low) and assigning a β or γ (which represents a subjective assessment of the degree to which that variable differs from its baseline, or neutral value). The costs of military failure and political failure are then assessed relative to one another and values assigned that represent their ratio. Armed with this information and the Tables listed in Chapter III, the equations that best represent the risk of military failure and the risk of political failure as functions of the delegation of control can be determined and graphically displayed. Examination of the resulting aggregate risk curve reveals the level(s) of control delegation at which aggregate risk is minimized. By planning and executing a military operation's command and control arrangements at the optimal level of delegation, the political leader can ensure minimum exposure to aggregate risk in the operation.

B. RISK SOLUTIONS

Applications of the risk model to military operations result in aggregate risk solutions that fall into one of three general categories: constant solutions, interior solutions and exterior solutions.

1. Constant Solutions

Constant solutions occur when the following two conditions are met: first, when the costs of military failure are equal to the costs of political failure; and second, when the political leader and the military commander experience the same rate of marginal change. The aggregate risk in a constant solution remains at the same level, regardless of the level of delegation of control. Thus, there is no optimal level of delegation in such an operation. An example constant solution is shown in Figure 18. It is interesting to note that while the aggregate risk does not vary with changes in the delegation of control, the component risks (risk of military failure and risk of political failure) vary considerably.

2. Interior Solutions

Interior solutions for aggregate risk occur when the political leader experiences increasing marginal changes in the risk of political failure and/or the military commander experiences decreasing marginal changes in the risk of military failure. The aggregate risk in an interior solution has a minimum at some level of delegation, $0 < D_C < 1$. Optimization of command and control involves arrangements to ensure the delegation of control approaches this value of D_C.

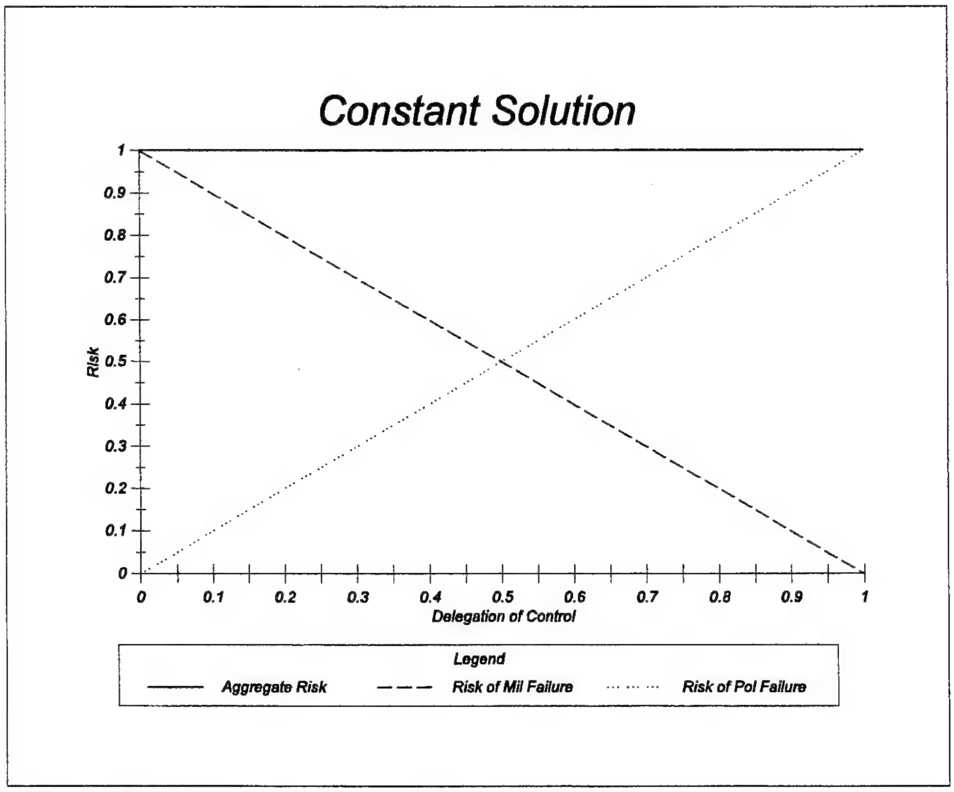

Figure 18. Example Aggregate Risk Solution with Constant Level of Risk

An example of a military operation with an interior solution is shown in Figure 19. Assessment of the key variables indicates that the political leader experiences increasing marginal changes in the risk of political failure while the military commander experiences

decreasing marginal changes in the risk of military failure. The minimum value for the operation's aggregate risk (0.14 units of risk) occurs at a delegation of control equal to 0.6. Optimization of command and control, therefore, involves arrangements to ensure the political leader delegates approximately 60 percent of the control over the operation to the military commander.

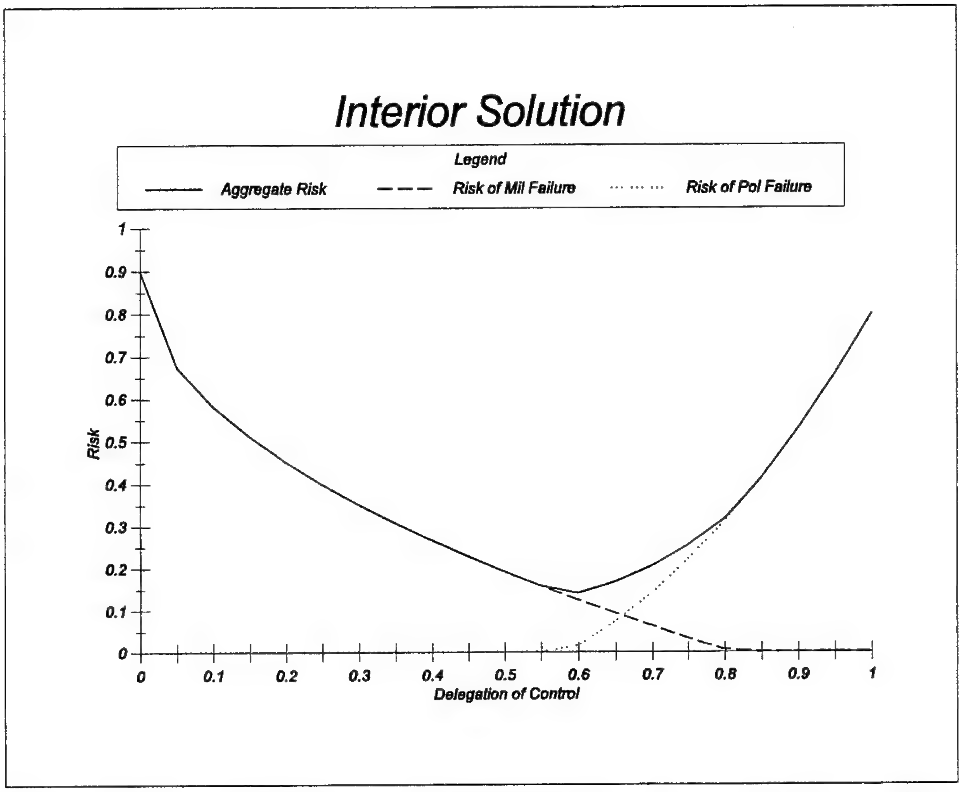

Figure 19. Example Aggregate Risk Solution with Interior Optimization Point

3. Exterior Solutions

Exterior solutions for aggregate risk occur when the political leader experiences decreasing marginal changes in the risk of political failure and/or the military commander experiences increasing marginal changes in the risk of military failure. The aggregate risk in an exterior solution has a minimum at D_C equal to either 0 or 1; the aggregate risk is

greater for all other levels of delegation. Such a solution suggests that the optimization of command and control occurs with either the political leader retaining all control (for operations with aggregate risk minimum at $D_C = 0$), or with him delegating all control to the military commander (for operations with aggregate risk minimum at $D_C = 1$).

An example of a military operation with an exterior solution is shown in Figure 20. Assessment of the key variables indicates that the political leader experiences decreasing

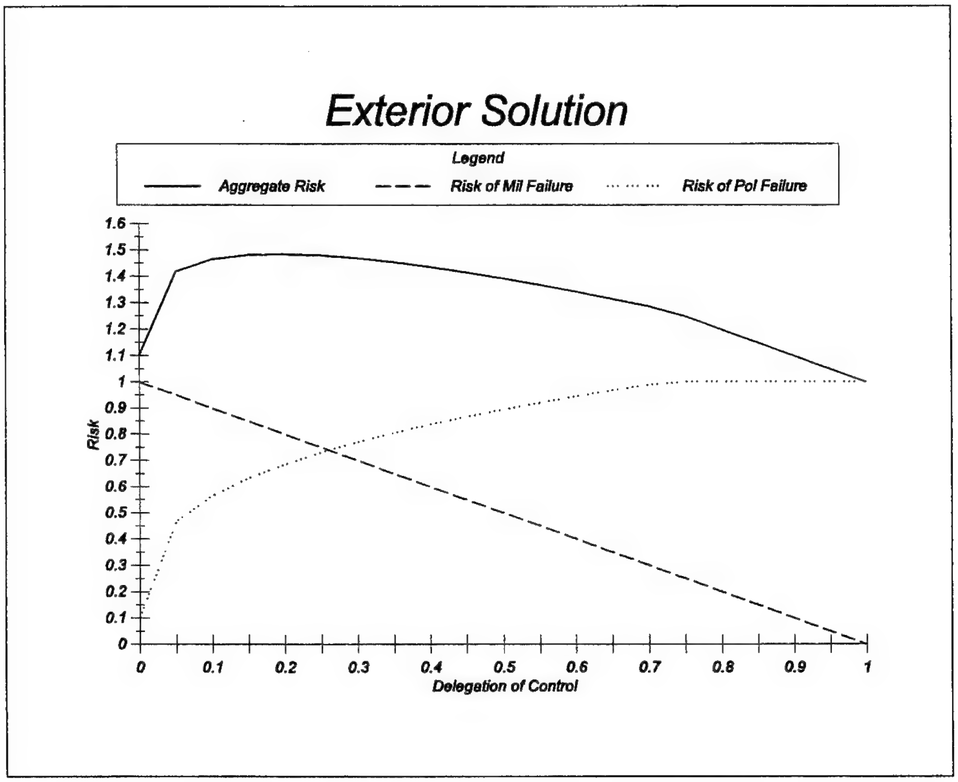

Figure 20. Example Aggregate Risk Solution with Exterior Optimization Points

marginal changes in the risk of political failure while the military commander experiences constant marginal changes in the risk of military failure. The minimum value for the operation's aggregate risk (1.0 units of risk) occurs at a delegation of control of D_C equal to 1.0. The level of aggregate risk is higher for all other levels of delegation. Theoretically

then, the optimization of command and control involves arrangements to ensure the political leader delegates complete control of the operation to the military commander.

C. ERROR TYPES

The aggregate risk solutions generated by the model indicate there are different ways in which errors can be made in the delegation of control. In general, there are three types of error that can occur with respect to the optimization of control. Type A errors occur when the political leader fails to delegate sufficient control to the military commander. They generally result from instances in which the political leader neglects to concentrate on minimizing aggregate risk and focuses instead on reducing the component risk of political failure.

The less common Type B error, on the other hand, occurs when too much control is delegated to the military commander. If the political leader discounts the risk of political failure and attempts to assist the military commander in reducing the risk of military failure, then a suboptimal delegation of excessive control will result.

Type C errors are the final category of mistake. Surprisingly, they occur when the level of delegation is locally optimal and the aggregate risk is at a local minimum. In military operations with a Type C error, the minimum level of aggregate risk exceeds the risk-bearing capacity of the political leader. In other words, the operation's expected cost is greater than the utility of political success.[5] In such a situation, the very best one can do is simply not good enough: the optimal delegation of control results in a minimized aggregate risk that remains excessive. Such a situation implies that the operation should not be undertaken; means other than military force should be utilized to pursue the political objective.

D. IMPLICATIONS OF RISK SOLUTIONS

Interior aggregate risk solutions are intuitively logical and rational. In fact, it appears that most senior policy-makers and military planners blindly assume such solutions. The

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[5]See the appendix for a more detailed explanation of expected cost and utility.

command and control procedures of almost all modern militaries include arrangements by which control over operations is divided between political leaders and military commanders. In more politically sensitive situations, these procedures usually allow the political leader to retain more control; conversely, in very risky military operations, the military commander is delegated more control. Such procedures suggest that most senior policy-makers envision the division of control between the political leader and the military commander to be a standard method of reducing an operation's overall risk of failure. The possibility of an exterior aggregate risk solutions, however, indicates that such a view is naive and that resulting command and control arrangements could result in a Type A or Type B error.

Constant and exterior aggregate risk solutions in military operations are less obvious and counter-intuitive. The aggregate risk in a constant solution remains at the same level, regardless of whether the political leader retains all, delegates some, or delegates all control. Thus, there is no optimal level of delegation. Exterior solutions imply that aggregate risk is minimized with either the political leader retaining complete control over the operation or delegating all control to the military commander. Neither of these options appear very practical in the real world.

The next two chapters explore the nature of different aggregate risk solutions in more detail. Chapter V looks at two real world military operations that have interior aggregate risk solutions. In addition to providing concrete examples of the application of the model to the real world, these case studies will be used as evidence, albeit incomplete, to support the validity of the risk model. The following chapter, Chapter VI, takes on the more difficult question of control over military operations expected to have high levels of both political and military risk. Using a hypothetical commando-style special operation as an illustrative example, the chapter will explore the inherent command and control dilemma faced by political leaders and military commanders in such operations and the risk management approaches suggested by the model.

V. EXPLAINING RISK: APPLICATIONS OF THE MODEL

In this chapter, two U.S. military operations conducted in the 1980's, Operation URGENT FURY and Operation EL DORADO CANYON, are analyzed using the risk model. These case studies have two purposes: first, to provide additional clarification and amplification of the model's mechanics; second, to provide evidence from the real world, albeit inconclusive, that validates conclusions drawn from the model and demonstrates their usefulness in explaining the risk dynamics of military operations.

A. TESTING THE MODEL

1. Limitations

There are inherent difficulties in any attempt to test a theory that includes risk as a dependent variable. The first is the lack of reliable indicators for measuring levels of risk. Risk is not a tangible object but rather, a concept that can only be measured indirectly. Additionally, the very nature of risk makes it extremely hard to produce even indirect evidence. One cannot assume that a high level of risk due to a suboptimal delegation of control will necessarily result in a failure. At the same time, however, a success does not prove that a high level of risk did not exist. The probabilistic nature of risk, combined with the fact that there are additional variables that explain success and failure in military operations, severely limit an attempt to provide conclusive evidence in support of the risk model.

2. Methodology

Despite the difficulties discussed above, the following two case studies attempt to provide evidence from the real world that supports the relationships postulated and conclusions drawn from the risk model. Both cases involve successful military operations that have interior aggregate risk solutions. Each study will demonstrate that the level of delegation suggested by the risk model was approximated by the actual command and control arrangements in use during the operation. The success of the operation, it is argued,

was partly due to the fact that the aggregate risk was minimized through the optimization of control. Such a conclusion tends to validate the concepts of the risk model.

In each study, a brief historical overview is first provided for background information. The operation is then examined in light of the key variables identified by the risk model. These variables are assessed and the aggregate risk model is constructed. The optimum level of control suggested by the risk model is then compared to the command and control procedures utilized by the actual political leader and military commander; the level of delegation suggested by the risk model is shown to approximate the control arrangements in use during the operation.

B. OPERATION URGENT FURY

1. Overview

On 23 October 1983, President Ronald Reagan directed the United States armed forces to execute a military invasion of the Caribbean island Grenada. Operation URGENT FURY was initiated two days later and represented the largest U.S. military undertaking since the evacuation of Vietnam almost a decade earlier. Before the invasion/rescue mission was completed, some 8,000 conventional and special operations personnel from all four services had participated in combat operations, supported by another 12,000 servicemen (Gabriel 1985, 154; Adkin 1989, 128). By any standard of measure, the operation has been judged a success, with both political and military objectives having been effectively attained.

A small group of observers in the Pentagon and State Department had been paying close attention to Grenada since 13 March 1979 when Maurice Bishop and his followers in the New JEWEL movement seized power from the unpopular Sir Eric M. Gairy. The new Grenadian government had a Marxist-dominated Central Committee that quickly established close ties with the Soviet Union and Cuba. In short order, these countries and other communist allies were supporting a significant military buildup on the island (Bolger 1988, 266-268). Although it came to power through unconstitutional means, the Bishop-led government proved popular with most Grenadians.

By 1983, however, growing differences between Prime Minister Bishop and his deputy, Bernard Coard proved irreconcilable. After rallying the support of party elites, the military and the militia, Coard convinced General Hudson Austin to take power in a coup on 13 October 1983 and Bishop was placed under house arrest (Bolger 1988, 271). Austin declared martial law and replaced the civilian government with his own Revolutionary Military Council (RMC). The situation in Grenada deteriorated even further six days later. Bishop supporters freed him from detention and persuaded him to fight Austin and the RMC. This counterrevolutionary initiative was quickly squelched by Austin and his forces; in the aftermath, Bishop and several of his primary supporters were ruthlessly executed.

The United States watched these events unfold with an ever-increasing interest. Already concerned with growing communist influence in the region, the Reagan administration feared the possibility of the RMC taking American citizens hostage and using them as bargaining chips in negotiations with the U.S.[6] The image of another Tehran nightmare loomed large as national security advisors debated policy options. When the United States received a formal request for assistance from the Organization of Eastern Caribbean States (OECS) on 21 October, President Reagan responded by authorizing Operation URGENT FURY.

The stated political objectives of Operation URGENT FURY were clear and concise. Hours after the operation was initiated, President Reagan announced his reasons for ordering the intervention: 1) to protect innocent lives (especially American citizens), 2) the restore order on the island, and 3) to replace the illegitimate military council with a democratically elected government (Payne 1984, 154). In hindsight, it is clear there were two additional political objectives that were left unstated. As previously mentioned, the United States was

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[6]Initial estimates indicated over one thousand American citizens were living in Grenada at the time, including approximately 700 medical students at St George's University School of Medicine (Payne 1984, 149). Although Austin initially vowed the Americans were free to leave, the discontinuation of telephone, airport and ferry services effectively trapped the U.S. citizens (Bolger 1988, 272) .

concerned with the growing influence of communism in the region. Especially worrisome was the prospect of Grenada becoming a military outpost of the Soviet Union and its clients. Reagan obviously hoped Operation URGENT FURY would stall further communist military expansion in the Caribbean (Adkin 1989, 110). Additionally, the United States desperately needed to restore the credibility of the its armed forces. On 23 October, a suicide bomber staged an attack on the marine barracks in Lebanon resulting in the deaths of 241 Americans. Since its humble departure from Vietnam, the U.S. military had suffered significant failures: the *Mayaguez* incident, Desert One, and now Lebanon. Clearly, the President hoped Operation URGENT FURY would assist in reestablishing the reputation of the American armed forces.

These political objectives were translated into military objectives by U.S. Navy Vice Admiral Joseph Metcalf and his staff. Then serving as Commander Second Fleet, Metcalf was assigned as the commander of the joint task force assigned with executing Operation URGENT FURY (JTF 120). After augmentation from the other services, the JTF staff hastily developed a concept of operations that focused on the following military objectives: securing the airports at Point Salines and Pearls, securing and evacuating American citizens, securing and evacuating Governor General Paul Scoon, capturing or destroying the key facilities Austin's forces, and capturing or destroying Cuban forces (Bolger 1988, 295).

Operation URGENT FURY was executed over a period of nine days. After initiating operations in the morning hours of 25 October, the JTF reported that all military objectives were secured by the evening of 27 October (Gabriel 1985,173); hostilities were not declared officially over, however, until 2 November (Adkin 1989, 308). On the first day, marines from the 22nd Marine Amphibious Unit (22nd MAU) conducted an air assault and secured Pearls airport in the north. Army Rangers conducted a parachute assault on the more heavily defended Point Salines airport in the south and secured the first of three major groups of American citizens. Navy SEALs sent to rescue the Governor General became trapped at his house and had to wait for reinforcements from the marines on the following day before being

able to safely evacuate. The main force, paratroopers from the Army's 82nd Airborne Corps, began arriving at Point Salines on the afternoon of the first day. Over the next 48 hours, these joint forces successfully accomplished the prescribed military objectives of Operation URGENT FURY.[7]

2. Analysis

An application of the risk model to Operation URGENT FURY demonstrates that the actual delegation of control exercised in the operation approached the optimal level of delegation predicted by the model. The success of the operation, it is argued, is partially the result of risk minimization through the utilization of an appropriate command and control arrangement.

In the following paragraphs, assessments of the risk model's key variables are made in light of the conditions surrounding Operation URGENT FURY. Using the methodology developed in Chapter III, these assessments will be used to determine the equations that best describe the relationships between the risks of military and political failure and the delegation of control.

a. Challenge of the Tactical Environment

The challenge of the tactical environment in Operation URGENT FURY is assessed as low, with a $\beta_1 = -0.1$. Although some estimates of the enemy order of battle included over seven thousand armed Cubans and Grenadians, evidence exists that suggests no senior decision-makers believed these estimates were accurate. As one armed force critic has noted,

> . . . in fact, no one at the JCS level ever took these estimates seriously or expected more than one thousand Cuban and Grenadians soldiers to fight. Certainly no one expected them to fight very well. The night before the

[7]This is not to say that the operation was flawlessly executed. There were, in fact, a number of operational mistakes and sub-task failures. In the end, however, the U.S. forces prevailed and attained the military objectives. For a thorough and accurate account of the operation, see Mark Adkin, *Urgent Fury*, (Lexington, Massachusetts: Lexington Books, 1989).

> invasion, the chairman of the JCS assured the President that American casualties would be light and the operation would go quickly, largely because of the number and quality of forces on the island, as well as their unsophisticated weapons (Gabriel 1985, 155).

Although American forces experienced pockets of strong resistance, the overall challenge presented by the enemy order of battle was low.

Likewise, the environmental and topographical conditions surrounding Operation URGENT FURY presented few significant challenges. Other than a squall at the beginning of the operation, the weather was not a limiting factor for military activities. The geography of Grenada, on the other hand, was somewhat more challenging. The volcanic landmass was dominated by steep hillsides and thick vegetation. Although certainly not insurmountable, these characteristics created some difficulties for force mobility.

The net assessment is that the challenge of the tactical environment is as low. Because of the difficulties posed by some of the topographic factors, the beta is assigned a moderate value, $\beta_1 = -0.1$.

b. Complexity of the Operation

The complexity of Operation URGENT FURY is assessed as high, with a $\beta_2 = 0.1$. The number of military tasks and subtasks that were expected to be accomplished by separate units was unusually high. In his analysis of Operation URGENT FURY's "strategic and operational objectives," historian Dan Bolger lists 23 separate, large-scale military tasks (Bolger 1988, 295). In addition to being executed by numerous, separate components of special operations and conventional forces, these tasks were to be carried out without the advantage of a deliberate planning cycle. In fact, the entire operation was "conceived, planned, and launched in four days" (Adkin 1989, 128). The attempt to coordinate the activities of some 20,000 personnel in such a short period of time added to the complexity of the operation; even routine tasks became more difficult with the lack of a deliberately prepared and well-briefed concept of operations. Because of the large number

of tasks, the variety of operating units and the lack of planning time, the complexity of Operation URGENT FURY is assessed as high and assigned a moderate value beta, $\beta_2 = 0.1$.

c. Readiness of the Force

The readiness of the force conducting Operation URGENT FURY is assessed as neutral (therefore, $\beta_3 = 0.0$). The military units involved were adequately prepared for the required operational tasks and sub-tasks. None of the assigned missions were outside the operational capabilities of the executing units. The level of training was generally very high. The special operations units employed and the 82nd Airborne Corps were always kept at a high state of readiness (Bolger 1988, 292). The 22nd MAU had recently completed their predeployment work-up and were embarked for transit to Lebanon (Adkin 1989, 119). On the down side, however, there was no chance for rehearsals prior to URGENT FURY. Additionally, airlift constraints limited some of the airborne forces to undermanned operating units (Adkin 1989, 194).

d. Complexity of the Political Objective

The complexity of the political objectives in Operation URGENT FURY is assessed as neutral (therefore, $\gamma_1 = 0.0$). The number and type of actors President Reagan had to deal with were within the capability of his diplomatic apparatus. The U.S. had good relations with the Caribbean Community (CARICOM) and the OECS. Although the U.S. did not have an embassy on Grenada, Milan Bish, U.S. ambassador to Barbados, did have communications with the RMC. U.S. and British officials were allowed to fly to Grenada on 22 October and meet with representatives from the RMC and Governor General Scoon (Bolger 1988, 272; Adkin 1989, 99). Overall, the U.S. had an adequate capability to coordinate and effect the desired end-state of Operation URGENT FURY.

e. Political Dynamism

The dynamism of the political environment in Operation URGENT FURY is assessed as low, with a $\gamma_2 = -0.05$. The political dynamism refers to the degree to which the political environment varies with time. After the RMC coup of 19 October, the overall

political environment in which President Reagan was operating was remarkably stable. In fact, some evidence suggests that the U.S. ignored petitions by the RMC and Cuba for a diplomatic solution to the crisis (Payne 1984, 153). This can be interpreted as an attempt to control uncertainty, keep the decision-making environment stable and maintain low political dynamism. Because of the unpredictable nature of events in Lebanon, however, the variable's gamma is assigned a small value, -0.05.

f. Linkage

The linkage between Operation URGENT FURY's military and political objectives is assessed as high, with a $\gamma_3 = -0.05$. The military objectives of the operation closely coincided with the political objectives, leaving little room for disconnects to develop. Of the five political objectives previously discussed, three could be attained through military action alone. Only two of the objectives, reinstalling a democratically elected government and deterring the spread of communism in the region, required inducing responses from other actors. Thus, the linkage is assessed as high, but with a relatively small gamma.

g. Cost of Military Failure and Cost of Political Failure

In the case of Operation URGENT FURY, the cost of a military failure and the cost of a political failure are assessed as equal to each other and, therefore, each assigned a value of 1. Because of the high degree of linkage between the military and political objectives, a cost of a failure at one level would have been approximately equivalent to the cost of a failure at the other. Additionally, both domestic and international audiences were sensitive to the operation and had the capability to respond to a failure. Reagan had to face the American public in a reelection bid later in the year. International actors had a variety of arenas in which to voice criticism: CARICOM, OECS, The Organization of American States and the United Nations.

3. Summary

A summary of the key variable assessments discussed above are presented in Table 3. Using the methodology developed in Chapter III, the equations that best represent the

VARIABLE	ASSESSMENT	BETA/GAMMA
Challenge of the Tactical Environment	Low	$\beta_1 = -0.1$
Complexity of the Operation	High	$\beta_2 = 0.1$
Readiness of the Force	Neutral	$\beta_3 = 0.0$
Cost of Military Failure	1	N/A
Complexity of the Political Objective	Neutral	$\gamma_1 = 0.0$
Political Dynamism	Low	$\gamma_2 = -0.05$
Linkage	High	$\gamma_3 = -0.05$
Cost of Political Failure	1	N/A

Table 3. Summary of Key Variable Analysis for Operation URGENT FURY

risk of military failure and the risk of political failure as a function of the delegation of control were determined to be:

$$R_{MF} = 1 - D_C \qquad\qquad R_{PF} = (D_C)^3 - 0.1 \qquad\qquad \textbf{(60)}$$

and are graphed in Figure 21.

4. Conclusions

The risk model shows that the aggregate risk in Operation URGENT FURY is minimized with a level of delegation equal to approximately 0.6.[8] This level of delegation indicates the military commander enjoys a significant amount of autonomy in his decision-making in the planning and execution of the operation. He does not, however, have total control over the operation; the political leader retains a small, but important amount of operational oversight. This oversight usually takes the form of designating political objectives, issuing general planning guidance and delimiting rules of engagement (ROE).

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[8]I make no attempt to quantify the exact meaning of a 0.6 level of delegation. The important point is that the aggregate risk is minimized when a large, but not complete, amount of control is delegated from the political leader to the military commander.

Accounts from the operation indicate these were the exact characteristics of the command and control arrangements utilized by President Reagan and Vice Admiral Metcalf.

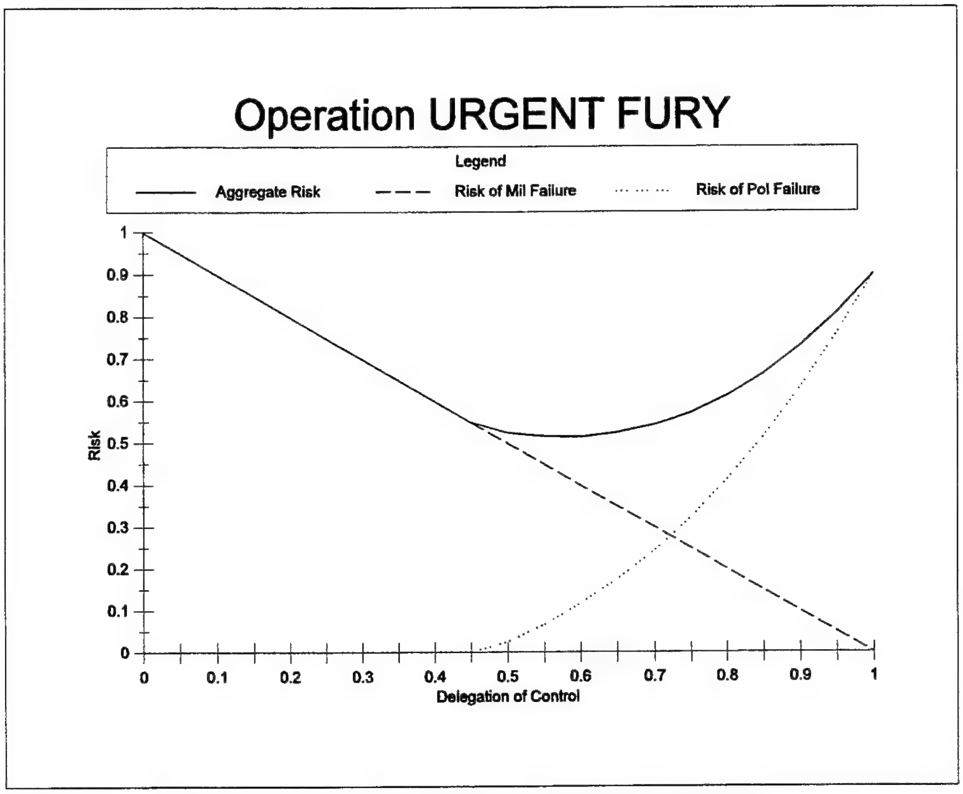

Figure 21. Aggregate Risk in Operation URGENT FURY

In his study of the operation, Bolger writes:

> URGENT FURY succeeded because President Reagan issued clear strategic goals and some general rules of engagement, then left matters to his competent military commanders. Reagan refused to permit political interference or civilian "micromangement" in the details of the special or conventional operations. Given the trust of the national commander in chief, the military establishment created a flexible combat organization that created a sound plan and executed it to fulfill the president's objectives. (Bolger 1988, 346)

Other descriptions of Reagan's approach to the delegation of control in Operation URGENT FURY confirm Bolger's assessment. For instance, Richard Gabriel writes that "the President

placed full operation control of the mission in the hands of the office of the Joint Chiefs of Staff. The JCS had a free hand in both planning and execution" (Gabriel 1985, 150). Adkin notes that the president did not "interfere with the military side of the operation" (Adkin 1989, 106). Both authors also note the use of rules of engagement designed to minimize civilian casualties and assist in the attainment of the political objectives (Adkin 1989, 339; Gabriel 1985, 176).

This evidence suggests that the optimal level of delegation, as predicted by the risk model, matched the level of delegation actually employed. Based on the specific circumstances of the situation, Reagan delegated the appropriate amount of control to the military commander; this optimization of control minimized the aggregate risk of the operations and, therefore, assists in explaining URGENT FURY's successful outcome.

C. OPERATION EL DORADO CANYON

1. Overview

EL DORADO CANYON was the last in a series of military exercises and operations conducted by the United States with the intent to thwart Libyan state-sponsorship of terrorism. Executed in the early morning hours of 15 April 1986, the operation consisted of over 120 Air Force and Navy attack and support aircraft striking five carefully selected target sites in Libya. The targets were effectively engaged and, although Qaddafi failed to completely terminate his associations with terrorist groups, "detectable Libyan involvement in terrorist activity dropped significantly in 1986 and 1987 after the US air raids in April 1986" (Zimmermann 1994, 217). The forces conducting EL DORADO CANYON successfully achieved the operation's military and political objectives.

Although Libya and its leader, Muammar Qaddafi, had been a constant source of aggravation for the Reagan administration, it was not until Libyan-sponsored terrorism threatened United States interests that the President decided to act. After two years of abstinence, Libyan-sponsored terrorists reemerged on the international scene and conducted 15 attacks in 1985 (Martin 1988, 259). In the aftermath of the Beirut bombing in 1984, the

United States had become more sensitive to the threat posed by terrorists. As part of an increasingly aggressive anti-terrorist policy, Secretary of State Shultz announced that the United States was seriously considering "more active means of defense -- about defense through appropriate preventative or preemptive actions against terrorists groups before they strike" (Zimmermann 1994, 201). Later, in July 1985, President Reagan openly acknowledged that the United States faced threats equaling "acts of war" by the terrorists and his administration prepared general plans to enable the United States "to hit back at the terrorists" (Davis 1990, 70). The stage was set for the showdown with Libya.

The incident that initiated the series of events leading to Operation EL DORADO CANYON occurred on 27 December 1985. Terrorists from the Libyan-sponsored Abu Nidal terrorist group conducted simultaneous grenade and gunfire attacks at the Rome and Vienna airports. Twenty people (five Americans) were killed including an eleven year old American girl. Evidence gathered after the incident implicated both Syria and Libya in the attacks (Davis 1990, 80-81). The day after the incident, Qaddafi called the attacks "heroic operations" and over the next few weeks engaged in open threats of terrorist attacks on American soil (Davis 1990, 79-81).

The initial United States response consisted of economic embargoes against Libya. This action lacked significant leverage, however, because Western allies in Europe were generally reluctant to go along with the United States' initiative. To increase its coercive pressure, during the months of January and February 1986, the United States conducted two "Freedom of Navigation" exercises in international waters north of Qaddafi's self-declared "line of death." These exercises amounted to a show of force designed to coerce Qaddafi into abandoning the sponsorship of international terrorism.

Continued Libyan defiance caused an escalation in the maneuvers. With the arrival of a third aircraft carrier in March, U.S. naval forces conducted a third "Freedom of Navigation" exercise in the Gulf of Sidra. This time, however, some of the ships operated in international waters south of the "line of death." Libyan anti-aircraft missile sites and fast

attack patrol boats attempted to engage these American forces but were unsuccessful. U.S. counter-actions resulted in the sinking of three patrol boats and the partial destruction of one missile site.

While the preceding events clearly escalated the crisis between the United States and Libya, it was two terrorist incidents in early April that served as the final catalysts for Operation EL DORADO CANYON. On 2 April, a bomb exploded on TWA Flight 840 from Rome to Athens, killing four people, all of them American. The Libyan-backed Abu Nidal group claimed responsibility for the attack, although evidence gathered later indicated a Syrian-sponsored, pro-PLO organization was behind the bombing (Davis 1990, 110; Martin 1988, 285). Regardless of who was culpable, this incident increased the desire of President Reagan to take action against international terrorism.

The final catalyst was an incident that occurred in Berlin on 5 April. A bomb exploded in the crowded La Belle nightclub, killing three people and injuring 229 others. The club was a popular nightspot for U.S. servicemen in Berlin; of the bombing's victims, two of those killed were American as were 79 of the injured. With the assistance of the British, the U.S. soon received communication intercepts between Tripoli and the Libyan East Berlin People's Bureau that clearly linked Libya to the bombing (Davis 1990, 116; Martin 1988, 285). President Reagan now had clear justification to act and authorized Operation EL DORADO CANYON on 6 April.

The political objectives of the operation were clearly stated by the President in his announcement of Operation EL DORADO CANYON to the American public. First and foremost, the airstrikes were "preemptive actions against terrorist installations" designed to "diminish Qaddafi's capacity to export terror." Additionally, it was hoped that the operation would "provide him with incentives and reasons to alter his criminal behavior." Finally, the President admitted that he held "no illusion that tonight's action would bring down the curtain on Qaddafi's reign of terror" but did believe the operation would "bring closer a safer and more secure world for decent men and women." (Davis 1990, 139)

The political objectives were translated into a series of carefully selected airstrikes against five target sites. Under the operational command of Vice Admiral Frank B. Kelso, Air Force and naval aircraft would engage military objectives in both the Tripoli and Benghazi area. In the vicinity of Tripoli, the target sites included: (1) Aziziyah Barracks, Qaddafi's personal compound and command and control center; (2) the Tripoli Military airfield; and (3) the Murat Sidi Bilal compound, a known training facility for terrorist frogmen. In the Benghazi area, the targets included: (4) the Benina airfield and (5) Jamahiriyah Barracks, Qaddafi's alternate command and control facility. The common theme among the targets was that all the sites were clearly elements of Libya's command, training and support infrastructure for the sponsorship of international terrorism.

Operation EL DORADO CANYON commenced on the afternoon of 14 April 1986 when U.S. Air Force tankers and support aircraft took off from airfields in the United Kingdom. Followed shortly afterward by the primary attack aircraft, 18 F-111's, this air armada began the long journey to their targets in Tripoli. The French refusal to grant overflight permission to the U.S. dictated a dogleg flight plan with a round-trip distance of almost 3,000 miles. After four in-flight refuelings, the F-111's started their attack profiles to engage their targets. With their first bombs on target at exactly 0200 GMT as planned, the F-111's effectively engaged the three Tripoli target sites and were on their way home eleven minutes later. Of the 18 aircraft comprising the strikes, 11 bombed as planned, five aborted their attacks, one missed the attack due to navigational errors and one aircraft was lost at sea. (Bolger 1988, 419-425)

As the Air Force armada was making its way toward Tripoli, the U.S. Navy was busy making preparations for the strike against the Benghazi targets. The carriers *America* and *Coral Sea* launched over 70 aircraft that would attack the Benghazi targets, suppress Libyan air defenses and provide local fighter protection for the F-111's over Tripoli. Like their counterparts from the U.K., the carrier aircraft hit their targets at exactly 0200 GMT. Of the 27 attack aircraft scheduled to bomb, 24 hit their target, two aborted on their attack run and

one aborted on the carrier. By 0253, all aircraft had been recovered onboard the carriers; Operation EL DORADO CANYON was over. (Bolger 1988, 419-425)

2. Analysis

As in the case of Operation URGENT FURY, a risk model examination of Operation EL DORADO CANYON reveals that the actual delegation of control exercised in the operation approached the optimal level of delegation predicted by the model. The success of the operation, then, is partially due to the minimization of aggregate risk through the utilization of an appropriate command and control arrangement.

In the following paragraphs, assessments of the risk model's key variables are made in light of the circumstances surrounding Operation EL DORADO CANYON. As in the last case study, these assessments will be used to determine the equations that best describe the relationships between the risks of military and political failure and the delegation of control. After plotting the aggregate risk solution, this section will compare the optimal and actual command and control arrangements.

a. Challenge of the Tactical Environment

The challenge of the tactical environment in Operation EL DORADO CANYON is assessed as low, with a $\beta_1 = -0.1$. The primary threat to the American forces was the Libyan air defense system. Although the weapons it manned had significant capabilities, the Libyan Arab Air Defense Command was "grossly understaffed, characterized by poor equipment maintenance, and probably left much to be desired in quality of training" (Davis 1990, 135). CDR Byron Duff, the air wing commander onboard the carrier *Coral Sea* remarked prior to the operation, "Outside of Syria and the Soviet Union, Libya has the best equipment in the world, whether they can operate it is another question" (Martin 1988, 269). Encounters with Libyan missile systems and aircraft in the preceding months had clearly demonstrated that Qaddafi's "men did not know how to employ their sophisticated weaponry" (Bolger 1988, 401).

Environmental and topographical conditions for the operation were generally favorable. The only topographical factor that posed a challenge was the location of Aziziyah Barracks; it was situated in the middle of a congested area of urban Tripoli. Because of the desire to avoid civilian casualties, the physical location of this target site made it a more difficult target than the rest. Aziziyah Barracks were, however, still well within the capabilities of the assigned forces.

The net assessment is that the challenge of the tactical environment is low. Because of the difficulties posed by the location of Aziziyah Barracks, the beta is assigned a moderate value, $\beta_1 = -0.1$.

b. Complexity of the Operation

The complexity of Operation EL DORADO CANYON is assessed as neutral (therefore, $\beta_2 = 0.0$). Achieving the mission's military objectives was dependent on, in essence, the additive result of each separate bombing crew's actions, not the synergistic effect of the multiple airstrikes. The success of the operation, however, did require a moderate degree of interdependency among the forces conducting the strikes. The plan called for simultaneous hits at all target sites to help achieve an element of surprise; the suppression of enemy air defense (SEAD) missions flown by some of the naval aircraft helped achieve air superiority for both naval and Air Force attack aircraft; the support of the tanker aircraft was essential to the employment of the F-111's. Overall, the number of interdependent tasks required to be performed in Operation EL DORADO CANYON was within the capabilities of the operating units; the complexity, therefore, is assessed as neutral.

c. Readiness of the Force

The readiness of the forces conducting Operation EL DORADO CANYON is assessed as high, with a $\beta_3 = -0.1$. The naval and Air Force crews conducting the operation were more than adequately prepared for the tasks and sub-tasks required by their operational assignments. Both carriers and their embarked airwings had operated in the vicinity of Libya in the "Freedom of Navigation" exercises in the previous months and had

actually engaged Libyan forces in the melee of 24 March. The naval aviators "knew their enemy's antiaircraft procedures, electronic signatures, and missile sites quite well by April 1986. Libya was familiar territory to many American fliers" (Bolger 1988, 410).

The Air Force units were almost equally well-prepared. At the beginning of the year, as contingency planning for possible operations against Libya was initiated, the F-111's based in England began rehearsing long-distance, multiple-refueling attack profiles to a bombing range near Incirlik, Turkey (Martin 1988, 274). These rehearsals were very similar to the profiles necessary to hit targets in Tripoli. During these practice runs, the crews developed and perfected the special procedures that would be required if France failed to grant overflight permission. The only difficulty arose when the draft Air Force mission tasking was changed four days before the strikes; the change increased the number of aircraft that would be required for the operation. Although the additional aircrews did not have the benefit of the Incirlik rehearsals, their training for the F-111's standard wartime tasking prepared them for the Libya mission. "The bombing tactics" they would use "against targets in Libya were the same ones they practiced for targets in Central Europe: low-level, nighttime runs that used the F-111's terrain-following radar" (Martin 1988, 273).

The overall assessment of the readiness of the force is high. Because of the difficulties posed by the last minute switch to a larger Air Force package, the beta is assigned a moderate value, $\beta_3 = -0.1$.

d. Complexity of the Political Objective

The complexity of the political objectives in Operation EL DORADO CANYON is assessed as neutral (therefore, $\gamma_1 = 0.0$). On the one hand, the complexity appeared low because the desired end-state of the operation was dependent on the actions of only one political leader. On the other hand, the political target of these efforts was far from a traditional statesman; Qaddafi was more of a revolutionary zealot than a conventional diplomat. Further adding to the complexity was the fact that the U.S. had closed its embassy in Tripoli in 1980; both countries did, however, maintain formal diplomatic relations

throughout this time period (Davis 1990, 38). The net impact of these factors was to establish a neutral level of complexity in the political objectives.

e. Political Dynamism

The dynamism of the political environment in Operation EL DORADO CANYON is assessed as neutral (therefore, $\gamma_2 = 0.0$). Based on the U.S.'s previous experiences with Qaddafi, it appeared highly unlikely that he would suddenly cede to the American demands. If Qaddafi did so cede, however, and the U.S. continued with its planned airstrikes, the result would have certainly been a political failure. The political environment surrounding Operation EL DORADO CANYON was neither especially dynamic nor static.

f. Linkage

Like the other variables affecting the probability of political failure, the linkage between the military and political objectives in Operation EL DORADO CANYON is assessed as neutral (therefore, $\gamma_3 = 0.0$). The military objectives of the operation were carefully selected to ensure a direct relationship with the political objectives. President Reagan had made it clear that he was willing to use "force as an instrument of counterterrorism only if it could target people or facilities directly related to the terrorism" (Zimmermann 1994, 205). The military objectives, however, were limited in nature and would not totally destroy Qaddafi's terrorism support infrastructure. The airstrikes were more of a message than they were a hammer. As a result, the linkage between the military and political objectives was incomplete; attainment of the political objective depended on inducing the appropriate response from Qaddafi.

g. Cost of Military Failure and Cost of Political Failure

As in the previous case study, the cost of a military failure and the cost of a political failure in Operation EL DORADO CANYON are assessed as equal to each other and, therefore, each assigned a value of 1. A military failure could have increased the prestige of Libya and its armed forces in the eyes of the world, regardless of the reasons for

the failure. Qaddafi and his revolutionaries would be seen as having successfully stood up to the imperialist Yankees. A political failure, on the other hand, would result in continued Libyan-sponsored international terrorism. The military operation itself might be seen as justification for not only Qaddafi's status quo level of terrorist activities, but even an increase. In either case, the ongoing confrontation between the U.S. and Libya had sensitized both domestic and international audiences to the potential for a military operation. Additionally, each audience had a wide variety of means to respond to a failure. Both the cost of military failure and the cost of political failure were equally intimidating.

3. Summary

A summary of the key variable assessments discussed above are presented in Table 4. Using the methodology developed in Chapter III, the equations that best represent the risk of military failure and the risk of political failure as a function of the delegation of control were determined to be:

$$R_{MF} = 0.8 - \sqrt[3]{D_C} \qquad\qquad R_{PF} = D_C \tag{61}$$

and are graphed in Figure 22.

4. Conclusions

The aggregate risk solution for Operation EL DORADO CANYON indicates that the optimal level of delegation is approximately 0.2. As before, the purpose of the risk model is not to distinguish the difference between a 0.2 level of delegation and a 0.3 level; what is of concern is that the risk model indicates the optimal command and control arrangements involve the political leader retaining a large amount of control, but not total control, over the operation. An analysis of the relationship between the political leader, President Reagan, and the military commander, Vice Admiral Kelso, reveals that the actual level of delegation utilized in the operation was similar to the optimal level of delegation predicted by the

model. The success of the operation, it is argued, is at least partially the result of risk minimization through the optimization of control.

President Reagan and his National Security Council (NSC) staff exercised close control over many aspects of Operation EL DORADO CANYON. Specifically, they were heavily involved in the operation's target selection and efforts to minimize civilian casualties. As previously discussed, the President insisted on a high degree of linkage between the targets and Qaddafi's involvement in terrorism. He and his staff closely reviewed the proposed target list before the execution of the operation. In fact, the President was personally responsible for adding Aziziyah Barracks to the final list of targets (Martin 1988, 288; Zimmermann 1994, 214).

VARIABLE	ASSESSMENT	BETA/GAMMA
Challenge of the Tactical Environment	Low	$\beta_1 = -0.1$
Complexity of the Operation	Neutral	$\beta_2 = 0.0$
Readiness of the Force	High	$\beta_3 = -0.1$
Cost of Military Failure	1	N/A
Complexity of the Political Objective	Neutral	$\gamma_1 = 0.0$
Political Dynamism	Neutral	$\gamma_2 = 0.0$
Linkage	Neutral	$\gamma_3 = 0.0$
Cost of Political Failure	1	N/A

Table 4. Summary of Key Variable Analysis for Operation EL DORADO CANYON

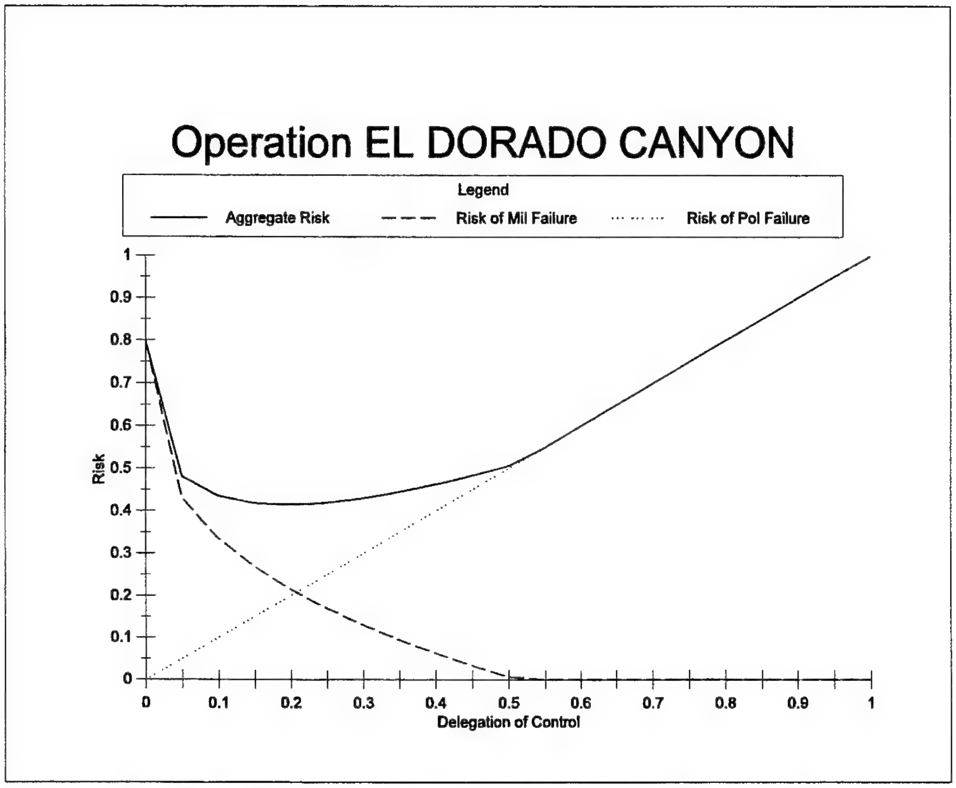

Figure 22. Aggregate Risk in Operation EL DORADO CANYON

The President's mandate to minimize civilian casualties was reflected in the strict ROE issued to the aircrews and the tactics utilized in the strikes:

> The crews were forbidden to drop their bombs unless they could make redundant positive target identification on multiple aiming systems; additionally, the use of standoff tactics to avoid risking the crews' lives in flight over the targets was rejected in order to minimize civilian casualties. (Davis 1990, 135)

Because of these strict, "double-lock" ROE, seven aircraft aborted their bombing runs during the operation when components of their navigation and targeting systems failed (Bolger

1988, 423). Through the use of ROE, the President had exercised a large degree of indirect political control over the execution of the operation.

While President Reagan maintained a great deal of control over the operation, he did not exercise total control. Mindful of the danger of retaining too much control, Reagan "insisted that [Vice Admiral] Kelso control the timing and details of any attack" (Bolger 1988, 416). In fact, many of the "more detailed aspects, such as munitions loadings and attack profiles were handled by more junior military commanders in the European theater" (Davis 1990, 119).

The details presented here suggest that the optimal level of delegation, as predicted by the risk model, matched the level of delegation actually employed. Based on the specific circumstances surrounding Operation EL DORADO CANYON, the political leader retained the appropriate level of control and minimized the operation's aggregate risk. This risk minimization through the optimization of control helps to explain Operation EL DORADO CANYON's successful outcome.

D. EVALUATING THE EXPLANATIONS

As discussed at the onset of this chapter, definitively testing the risk model is inherently difficult, if not impossible. The case studies presented here, therefore, are admittedly inconclusive in nature and fail to absolutely prove the validity of the concepts on which the model is based. Additionally, the assessments and beta assignments made for the model's key variables in these case studies are subjective; others may have legitimate arguments with the assessments made or their supporting justifications. Such are the difficulties in attempting to grapple with concepts as vague as risk in military operations.

These critiques notwithstanding, it appears the model provides a useful guide to the general level of delegation most appropriate for the command and control arrangements of a particular military operation. The first case study demonstrates the usefulness of decentralized control when the political situation permits a high level of delegation to the military commander. In Operation URGENT FURY, the military risks dominated the

political risks; the decentralized approach to command and control that was exercised effectively reduced the aggregate risk and granted the military commander the flexibility required to handle the military risks.

Operation EL DORADO CANYON, on the other hand, illustrates the necessity for centralized control when the political risks dominate the military risks. The average risk of political failure coupled with the relatively low risk of military failure required the political leader retain a high level of control to reduce the operation's aggregate risk and provide himself with the flexibility necessitated by the political environment.

The risk model, then, appears to be an accurate barometer for the degree of centralized control appropriate to a particular military operation. But what of military operations in which both the risk of military failure and the risk of political failure are high and neither dominates? Such a situation is typical of special operations and the command and control dilemma is expected to be greatly amplified in such circumstances. How does one interpret, and what are the implications of the model's aggregate risk solutions for such operations? These questions are the subject of the next chapter.

VI. PREDICTING RISK: SPECIAL OPERATIONS AND THE RISK MODEL

A. PURPOSE

In the preceding chapters, we have developed a model for analyzing risk in military operations and demonstrated its usefulness in explaining the dynamics of risk in selected historical cases. In this chapter, we shift our focus to the future and use the model to predict risk in hypothetical operations, specifically, special operations. The ultimate goal, of course, is to determine the command and control arrangements for such operations that minimize exposure to aggregate risk.

There are two primary reasons for looking at special operations. First, such operations are increasingly important to the national security strategy of the United States. As General Wayne Downing, Commander in Chief of the United States Special Operations Command recently noted, special operations forces (SOF) are "in demand overseas because we have some unique skills that this country needs in this era of international challenge" (Downing 1995, 11). Additionally, special operations are normally associated with high political risks and high military risks. As a result, the command and control dilemma can be expected to be greatly amplified in such operations as the political leader and military commander struggle for control in an attempt to minimize their respective risk. An application of the risk model to a special operation, therefore, provides an excellent opportunity to demonstrate its usefulness in the management of the command and control dilemma.

B. SPECIAL OPERATIONS

1. Definition and Characteristics

Before using the model to analyze risk in special operations, a look at the definition and characteristics of such operations is required. The United States military defines special operations as:

> operations conducted by specially organized, trained and equipped military and paramilitary forces to achieve military, political, economic, or psychological objectives by unconventional military means in hostile, denied, or politically sensitive areas. These operations are conducted during peacetime competition, conflict, and war, independently or in coordination with operations of conventional, non-special operations forces. Political-military considerations frequently shape special operations, requiring clandestine, covert, or low visibility techniques and oversight at the national level. Special operations differ from conventional operations in degree of physical and political risk, operational techniques, mode of employment, independence from friendly support, and dependence on detailed operational intelligence and indigenous assets. (Joint Pub 3-05 1992, GL-20)

Several elements of this definition warrant closer inspection.

The definition emphasizes that SOF are "specially organized, trained, and equipped military" units specifically designated for employment in special operations. SOF doctrine states that such personnel "undergo lengthy selection processes and extensive mission specific training programs above basic military skill training." These military units "are often organized jointly and routinely plan, execute, command and control operations from a joint perspective." In order to develop and maintain their special skills, SOF are directed by doctrine to "train and exercise under conditions resembling the operational environment in which they intend to fight." As a result, most SOF components are regionally focused in order to maintain a "capability to execute all foreseeable operations in the full range of the area's environmental conditions." (Joint Pub 3-05 1992, I-6)

The definition also stresses the political aspects of special operations. Political considerations normally exert a great influence on the planning and execution of special operations. SOF doctrine states that special operations are "usually of high physical and political risk . . . often principally politico-military in nature . . . and subject to oversight at the national level. (Joint Pub 3-05 1992, I-4)

2. Commando and Unconventional Special Operations

There are five principal mission areas for SOF: direct action, special reconnaissance, counterterrorism, foreign internal defense and unconventional warfare. Direct action

operations are generally small-unit, offensive strikes against key enemy targets. Special reconnaissance, also known as "eyes on target," is usually concerned with the collection of intelligence in hostile, denied or politically sensitive areas. Counterterrorism operations seek to preempt or resolve terrorist incidents. Foreign internal defense missions attempt to train and advise the military and paramilitary forces of developing states with the goal of preparing such forces for counterinsurgency operations. Unconventional warfare is an umbrella term used to describe the related tactics of guerrilla warfare, sabotage, and subversion as they apply to supporting insurgencies.

These wide-ranging mission areas can be usefully categorized into two basic roles for SOF: unconventional and commando. The unconventional role is distinguished by the employment of SOF to "influence, advise, train and conduct operations with foreign forces and populations." Operations in the unconventional warfare and foreign internal defense mission areas clearly fall into this role. Generally, unconventional operations are conducted over extended periods of time and "require a patient, long-term commitment in order to achieve national objectives." The characteristic long-term duration of such operations make it difficult to apply the risk model; the key variables of the model are likely to vary significantly over the period of the operation. (Lamb 1995, 4)

The second basic role for SOF is as commandos. In this role, SOF use "stealth, speed and audacity to undertake precision penetration and strike operations in limited, specialized contingencies across the conflict spectrum." The direct action, special reconnaissance and counterterrorism mission areas fall into the commando role. Commando operations are characterized as "short, self-contained . . . missions that stress unorthodoxy, special training and unique intelligence." As we explore risk in special operations, our focus will be on operations that fall into this role; the general nature and short duration of commando operations allows one to make credible generalizations and more accurate assessments of the risk model's key variables. (Lamb 1995, 4)

C. RISK IN COMMANDO OPERATIONS

In this section, we will apply the risk model to commando operations. The doctrinal definitions and characteristics of such operations, as previously discussed, will serve as the basis for evaluating the risk model's key variables.

1. Analysis of Key Variables

The key variables affecting the probability of military failure in a commando operation are all assessed at a neutral level and, therefore, have a beta of 0.0. Such an assessment may appear counter-intuitive at first glance; SOF are generally considered highly ready troops with specialized training in their expected mission areas and operational environments. These remarks are true when comparing SOF relative to conventional forces. Relative to the *commando operation at hand*, however, SOF are most accurately described as "adequately prepared" vice "exceptionally well prepared" for the inherent challenge of its tactical environment, complexity of the operation and required military tasks and sub-tasks. These key variables, therefore, are assessed at neutral levels.

In general, the complexity of political objectives in commando operations can be assessed as low, with a moderate value gamma, $\gamma_1 = -0.1$. Commando operations are usually directed against state, rather than non-state, actors. While the desired end state of unconventional operations may depend on the actions of a wide variety of state and non-state actors, commando operations are employed to achieve a specific goal or send a specific message to a specific political actor. In such situations, the number and type of actors with which a political leader must interact are well within the capabilities of his diplomatic apparatus.

In contrast to the low level of complexity in their political objectives, commando operations normally exhibit a high degree linkage and are usually executed in political environments with a high level of dynamism. As previously mentioned, commando operations are employed to achieve a specific goal or send a specific message to a specific political actor; thus, there is normally a very deliberate and explicit coupling between the

military objective and the political objective. As will be further discussed in the next paragraph, technological advances have brought about a general increase in the pace of diplomatic negotiations and, as a natural extension, in the dynamism of the political environment.

In commando operations, the cost of a military failure and the cost of a political failure are assessed as equal to each other and, therefore, each assigned a value of 1. The primary reason for this assessment is the "CNN effect." Rising literacy rates around the world, the proliferation of international media organs and the advances in tele-communications technology have created a geo-political environment in which a tactical error can result in a strategic failure. The sensitivity of both domestic and international audiences have risen, as have their means to effectively respond to both military and political failures. These recent changes and the high degree of linkage combine to blur the distinctions between military and political objectives in commando operations; the "battles" become "wars" and the "wars" become "battles." As a result, the costs of a military failure are indistinguishable from the costs of a political failure.

2. Summary

A summary of the key variable assessments discussed above are presented in Table 5. Using the methodology developed in Chapter III, the equations that best represent the risk of military failure and the risk of political failure as a function of the delegation of control are determined to be:

$$R_{MF} = 1 - D_C \qquad\qquad R_{PF} = (D_C)^{\left(\frac{3}{2}\right)} - 0.1 \qquad\qquad \textbf{(62)}$$

and graphed in Figure 23.

VARIABLE	ASSESSMENT	BETA/GAMMA
Challenge of the Tactical Environment	Neutral	$\beta_1 = 0.0$
Complexity of the Operation	Neutral	$\beta_2 = 0.0$
Readiness of the Force	Neutral	$\beta_3 = 0.0$
Cost of Military Failure	1	N/A
Complexity of the Political Objective	Low	$\gamma_1 = -0.1$
Political Dynamism	High	$\gamma_2 = 0.1$
Linkage	High	$\gamma_3 = -0.1$
Cost of Political Failure	1	N/A

Table 5. Summary of Key Variable Assessment for Commando Operations

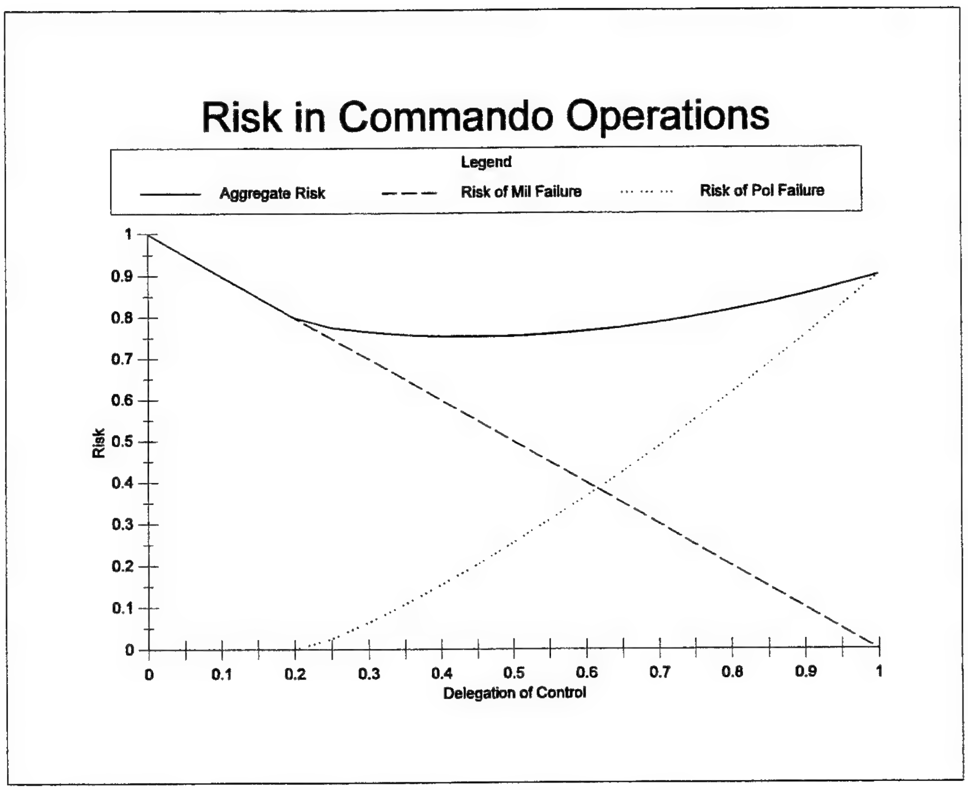

Figure 23. Aggregate Risk in Commando Operations

D. IMPLICATIONS FOR COMMAND AND CONTROL OF COMMANDO OPERATIONS

Analysis of the aggregate risk solution shown in Figure 23 reveals two important observations concerning the command and control of commando operations. First, the fact that commando operations have interior risk solutions implies that it is possible to effectively minimize risk in such operations through the optimization of control. In this example, risk is minimized with a level of delegation of approximately 0.44. Thus, the optimal command and control arrangement for commando operations would involve procedures that delegate slightly less than half of the control from the political leader to the military commander. Such an arrangement minimizes risk and provides for the most effective means of managing the inherent command and control dilemma.

The second important observation from an analysis of the aggregate risk solution for commando operations is that a Type B error (too much delegation) is preferable to a Type A error (not enough delegation) in the command and control arrangements. The slope of the aggregate risk curve in Figure 23 rises more quickly to the left of the optimization point than it does to the right. Additionally, the aggregate risk rises to a value of 1.0 with an extreme Type A error, as opposed to a value of 0.9 with a comparable Type B error. The conclusion to be drawn is non-trivial: in general, it is advantageous for the political leader to favor more delegation to the military commander than less.

VII. CONCLUSIONS

A. MODEL ASSESSMENT

The preceding chapters have highlighted the strengths and usefulness of the risk model developed in this thesis: it provides a systematic methodology for thinking about risk in military operations; it introduces the concept of aggregate risk and provides a tool for understanding the command and control dilemma; finally, it provides a framework for enhancing operational success through a strategy of risk management. The model is not, however, without its weaknesses. This section briefly addresses what I consider are the three primary weaknesses of the model.

First and foremost, the risk model assumes that the military commander makes his decisions in a political vacuum and that such decisions are based only on military preferences. This assumption was necessary for simplicity, but it led to the model's generalized high probability of political failure when the political leader delegates a significant amount of control to the military commander. In reality, no military decision is made with such total disregard to political considerations. We would expect, therefore, that the political and aggregate risk curves in the real world are actually "flatter" than those generated by the model.

A second weakness in the model is its assumption of a linear baseline relationship between the delegation of control and probability of a military or political failure. Again, this assumption was made to keep the model as simple as possible. One can imagine, however, that this relationship may be more accurately described by a step function than a linear one. A step function would indicate that there exists a threshold level of delegation at which the probability of failure exhibits a large change; both below and above this threshold level of delegation, the probability of failure would exhibit small marginal changes. Such a baseline relationship may more accurately reflect the nature of risk in military

operations, but would also add a level of complexity to the model that might negate it analytic usefulness.

The final weakness of the risk model is its lack of an operationalized "delegation of control continuum." What does 0.3 units of "delegation of control" look like in the real world and what distinguishes it from level of 0.2 or 0.4? As presented in this thesis, the risk model indirectly avoids these questions by relying on generalized characteristics of "more" and "less" delegation. Such generalizations are acceptable in an exploratory work such as this, but a more specific discussion of the "delegation of control continuum" in practical terms would increase the usefulness of the model.

These weaknesses notwithstanding, I believe that the risk model developed in this thesis provides not only a useful tool for understanding the nature of the command and control dilemma but also the means for managing its effects.

B. RISK AND THE COMMAND AND CONTROL DILEMMA REVISITED

The political and military risks associated with a military operation serve as powerful catalysts for the struggle over control. Political risks increase the desire for control by the political leader who wants to ensure the tactical objectives and means are consistent with the existing political requirements. Military risks, on the other hand, increase the desire for control by the military leader; he desires maximum autonomy in order to effectively conduct the battle and respond to contingencies. Thus, each leader is driven by his perception of risks to struggle for increased control over the operation. The end result is the command and control dilemma: a natural tension between the political leader and military commander, between the need to maintain control and the need to delegate.

The model developed in this thesis provides a conceptual framework for analyzing the risks faced by each leader and these risks' relationship to each other. The thesis shows that an operation's overall risk, or aggregate risk, is the sum of the military risk and the political risk. The components of these risks, "costs of failure" and "probability of failure," are examined along with the significant factors that affect each. The mathematical model

formulated in Chapter III provides a mechanism for examining the variations in an operation's military, political and aggregate risk as a function of the delegation of control. The resulting insight into the dynamics of risk in military operations allows for the effective management of the command and control dilemma.

In every military operation, a command structure is organized for the execution of the plan and the control of the military units; this establishment of a command relationship between the political leader and military commander implies the delegation of some degree of autonomous decision-making authority. The paradigm fostered by the risk model shifts the focus away from the command and control dilemma's inherent struggle over control; instead, the model sharply focuses both the political leader and military commander on minimizing *aggregate* risk through the optimization of control. The utilization of command and control arrangements that reflect the optimum level of delegation, as determined by the risk model, results in the minimum possible exposure to overall risk and improves the probability of a successful military operation.

C. PRECEPTS FOR RISK MANAGEMENT

In addition to the strategy of risk minimization just discussed, an analysis of the conceptual framework provided by the risk model also yields a set of general precepts for the management of risk in military operations. Obviously, the minimization of aggregate risk is the most effective means of enhancing mission success. A useful secondary goal, however, is to "lower" the whole aggregate risk curve. Any individual action that lowers either the component military or political risk curve will result in a lower aggregate risk regardless of the level of delegation. It follows that the political leader and the military commander should endeavor to take those actions that would result in lower assessments of

one or more of the risk model's key variables. As a result, the following precepts for risk management in military operations can be derived from the model developed in this thesis:

- Ensure the force is prepared for the operation's tactical environment.
- Ensure the force is prepared for the operation's required military tasks.
- Minimize the number of sequential/simultaneous tasks required by the operation.
- Keep the operation's desired end-state as simple as possible.
- Attempt to minimize variations in the operation's political environment.
- Maximize the coupling between the operation's military objective and its political objective.

The greater the degree to which these precepts are accomplished during the planning, preparation and execution of military operations, the lower the overall aggregate risk exposure and the greater the prospect of mission success.

APPENDIX. PROOF OF THE ADDITIVE NATURE OF RISK IN MILITARY OPERATIONS

For the purposes of this thesis, a military operation is defined as the tactical application of force employed by a state in the pursuit of specific military objectives that contribute to the attainment of an overall political objective. A graphical representation of this definition is presented in Figure 24.

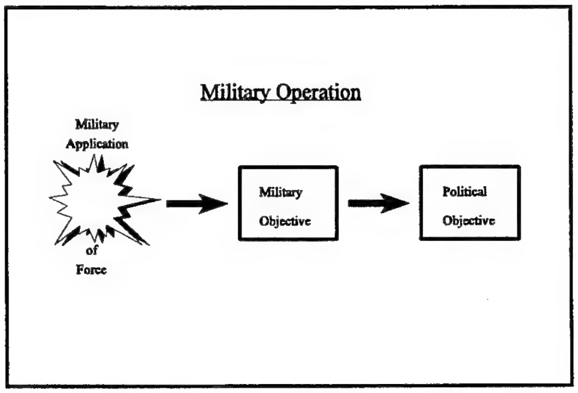

Figure 24. Diagram of Military Operation

The success of any military operation requires 1) that the military objective is appropriately determined and attained, and 2) that the political objective is appropriately determined and attained. Each objective is a necessary but not sufficient condition for success. There are, therefore, two ways in which a military operation can fail: militarily and politically. A military failure occurs when the political objective of a military operation is not attained due the failure of the application of force to achieve the military objective. A political failure occurs when the political objective of a military operation is not attained even though the application of force successfully achieves the military objective.

Based on the preceding definitions, a military operation has three possible outcomes: a military failure (the military objective is not attained), a political failure (the military objective is attained, the political objective is not attained), and a political success (both the

military and political objectives are attained). These possible outcomes can be represented in a Venn diagram as shown in Figure 25.

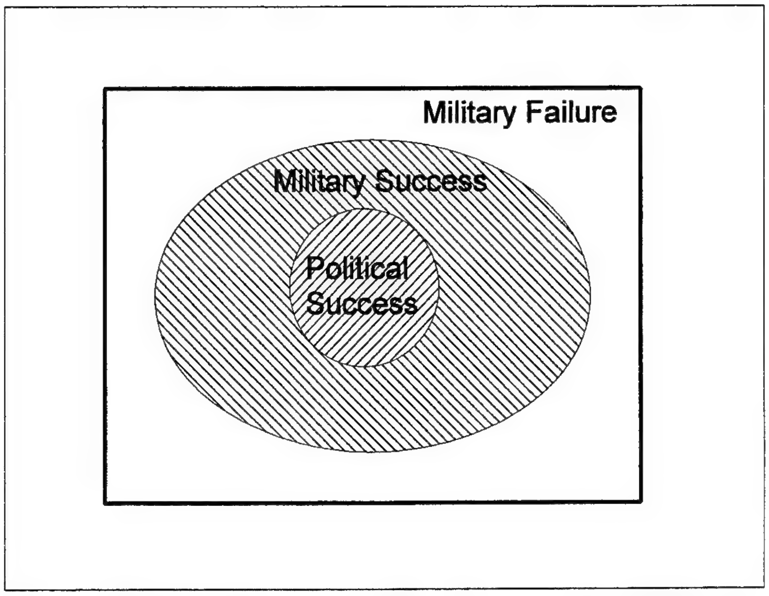

Figure 25. Venn Diagram of the Outcomes of a Military Operation

Since the sum of the probability of each outcome equals 1, the following equation can be deduced from the Venn diagram:

$$P(\mathit{Military\ Failure}) + P(\mathit{Military\ Success} \wedge \mathit{Political\ Failure}) + P(\mathit{Political\ Success}) = 1 \quad \textbf{(63)}$$

Since we have already defined a political failure as occurring when the military objective is attained but the political objective is not, this equation can then be simplified as:

$$P(\mathit{Military\ Failure}) + P(\mathit{Political\ Failure}) + P(\mathit{Political\ Success}) = 1 \quad \textbf{(64)}$$

$$P_{MF} + P_{PF} + P_{PS} = 1 \quad \textbf{(65)}$$

The expected utility of a military operation is the sum of the product of the probability of each possible outcome and the utility assigned to that outcome. Thus,

$$\textit{Expected Utility} = P_{MF}U_{MF} + P_{PF}U_{PF} + P_{PS}U_{PS} \tag{66}$$

We know from the Venn diagram that:

$$P_{PS} = 1 - P_{MF} - P_{PF} \tag{67}$$

Substituting for P_{PS} in the expected utility equation yields:

$$\textit{Expected Utility} = P_{MF}U_{MF} + P_{PF}U_{PF} + (1 - P_{MF} - P_{PF})U_{PS} \tag{68}$$

$$\textit{Expected Utility} = P_{MF}(U_{MF} - U_{PS}) + P_{PF}(U_{PF} - U_{PS}) + U_{PS} \tag{69}$$

Conceptually, the difference between the utility of a military failure and the utility of a political success can be referred to as the *cost of a military failure*, or C_{MF}. Likewise, the difference between the utility of a political failure and the utility of a political success can be referred to as the *cost of a political failure*, or C_{PF}. Substituting these terms into the expected utility equation now yields:

$$\textit{Expected Utility} = P_{MF}C_{MF} + P_{PF}C_{PF} + U_{PS} \tag{70}$$

The difference between the expected utility of a military operation and the utility of a political success can be referred to as the *expected cost of a military operation*. Therefore, subtracting U_{PS} from each side yields:

$$\textit{Expected Cost} = P_{MF}C_{MF} + P_{PF}C_{PF} \tag{71}$$

Note that one should only pursue a military operation when the operation's expected cost is

less than the utility of political success. Otherwise, one should maintain the staus quo and receive the reference utility of zero.

In this thesis, risk is defined as the product of "cost" and "probability." The expected cost of a military operation, therefore, is the aggregate risk of a military operation. If we let R_A represent the aggregate risk, R_{MF} represent the risk of military failure, and R_{PF} represent the risk of political failure, the above equation can be rewritten as:

$$R_A = R_{MF} + R_{PF} \tag{72}$$

Thus, risk in military operations, as defined in this thesis, is additive.

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